NOVEMBER 1985 VOL. 3, No. 11 $3.95

FOR IBM PERSONAL COMPUTER USERS

PC TECH JOURNAL

14 TAPE BACKUP SYSTEMS

INSIDE THE AT/370

NOVELL'S NETWARE

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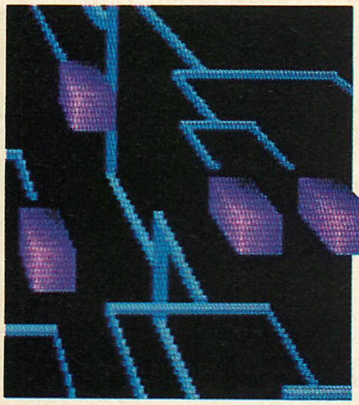

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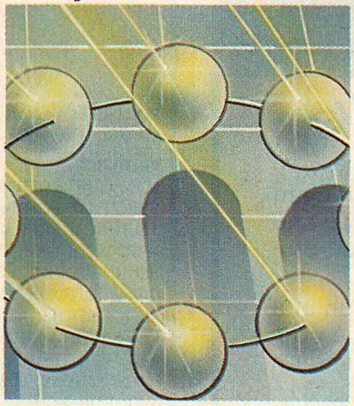

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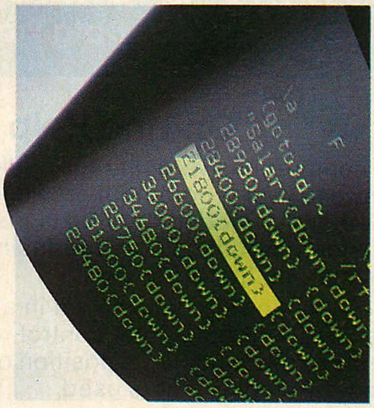

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Cover photograph · Jay Brenner

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EDITORIAL OFFICE
PC TECH JOURNAL, The World Trade Center, Suite 211, Baltimore, MD 21202. 301/576-0770. MCIMail: PCTECH. PCTECHline: 301/576-PCTJ.

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Introducing Periscope II

Professional Debugger with Break-out Switch

30-Day Money-Back Guarantee

What Users Say:

"Very powerful for debugging and testing. Great product! Better than Atron by far."
—Wynn Bailey

[Periscope is] "the most essential element of my 'developer's tool box' . . . Every PC used for development at Microstuf has a Periscope board installed and in use on a daily basis . . . Anyone trying to write software on a PC who's not using Periscope is wasting either time, money, or both." —Jeff Garbers

Now there are TWO Periscopes! The original "board" model includes the write-protected RAM board. It is called Periscope I. The new "software" model does not include the write-protected RAM board. It is called Periscope II. We specify 'I' or 'II' only for features not in both models.

Periscope is "Always there with just a push of the button." Install the switch and software, then go about business as usual. Until your system hangs or the keyboard locks up or you just get curious about what's going on . . . then press the break-out switch and Presto! Periscope's debugging power is at your command. When you return to the executing program, it won't even know that Periscope has been there.

Save time with symbols and source code. They give you a roadmap through memory! Periscope uses names—symbols—from your program so you don't have to remember addresses. It displays source code and line numbers from high-level languages, too. You save hours of time because you access what you need with familiar names!

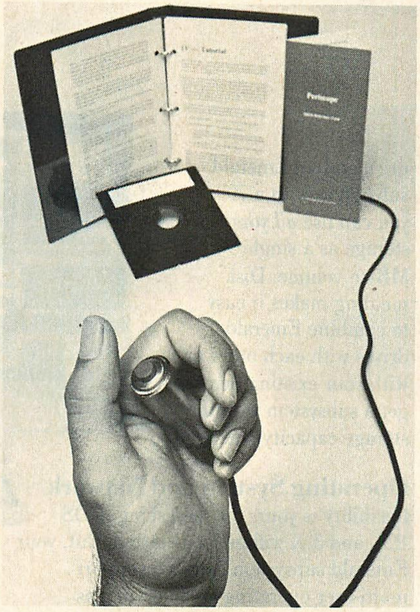
Can debugging be fun? With Periscope it can! Here's why:

It's Fast! Written entirely in assembler to save you time.

It's Easy! Commands similar to Debug's, optional on-line help, quick-reference card, tutorial, 150+ page manual, and support direct from the author—all you need to get up to speed quickly.

It's Flexible! You can:

- Enter Periscope via break-out switch, program loader, or assigned keys
- Define up to four windows for data, register, stack, and disassembly information; change them any time
- Display memory in ASCII, byte, word, double word, integer, or signed integer
- Design your own templates to display memory in easy-to-read formats
- Customize Periscope with your own programs via the user exit capability
- Assign frequently-used commands to function keys



The break-out switch really sets Periscope II apart from typical software-only debuggers. It installs easily, without taking an extra slot.

It's all there! Periscope includes all the standard debugger features, plus extras like supporting the use of one or two monitors, enabling you to search for address references, etc. The latest version includes new and enhanced features to help you debug your programs faster and easier than ever before:

New!	In-line Symbolic Assembler
Enhanced!	75+ Breakpoint Options
New!	Traceback
Enhanced!	Optional Windows
New!	Source-Level Debug
New!	View text files
New!	EGA Support
New!	User Exits
New!	8087/80287 Status
	Much More!

Periscope's unique breakpoint power forces bugs out from where they hide! With over 75 breakpoint options, including both temporary and sticky code breakpoints, you'll find elusive bugs fast. For instance, you can break on register, byte and word values; stop on execution of source lines and interrupts; break on reads and writes to ranges of I/O ports and ranges of memory using various tests. The memory breakpoint is great for debugging C programs with broken pointers. You can even write your own custom breakpoint tests!

Periscope requires: An IBM PC, XT, AT or close compatible; DOS 2.0 or later; 128K RAM; Disk Drive; an 80-column Monitor.

What Reviewers Say:

"This product is a reliable and useful tool for any programmer's workshop. A number of innovative, helpful features are yours for the taking." —Programmer's Journal

"Periscope has excellent on-line help. We were impressed by Periscope's very fast response in all its operations. It is a pleasure to use, and a refreshingly different product . . . offers great value and unique advantages." —Boston Computer Society

Debug any program, any time! Periscope is, in one user's words, "Robust". Use it to debug almost any program, even device drivers, memory-resident, and non-DOS programs. Debug when DOS is broken; debug DOS. Periscope won't let you down when you need it.

User calls Periscope I "Bulletproof"! The installation program in Periscope I loads the crucial debugger software into the RAM board and write-protects it. No runaway program can touch this code! Coupled with the break-out capability and the built-in reliability of the software, this protection gives you the most powerful crash recovery system available.

"Outstanding value for the services offered" writes one user. ***"Worth the price!"*** writes another. With the 30-Day Money-Back Guarantee, you can't lose! If you're not satisfied with Periscope for any reason, just return it within 30 days of receipt for a full refund.

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AT Powe

High performance, high capacity hard disk subsystems

A Single DOS Volume up to 240 formatted MBytes in size on your PC is only the beginning of Emerald subsystems' features. However, it is a very important one to many of our customers.

Most serious micro computer users are familiar with the infamous *32 MByte DOS Barrier*. Some of you have only read about it; others have run up against it head on when trying to run PC Focus or a downloaded mainframe program.

If you are one of those who have hit it head on you'll be pleased to know that *for almost a year Emerald has been shipping fixed disk subsystems that solve your problem*. Subsystems. Plural.

All Emerald subsystems can be operated as a single volume up to their formatted capacity. That includes our 36, 50, 70 and 140 MByte subsystems, in addition to the 280.

```
C>chkdsk

237633536 bytes total disk space
    65536 bytes in 2 hidden files
    49152 bytes in 2 user files
237518848 bytes available on disk

   262144 bytes total memory
   205152 bytes free
```

Actual printout of CHKDSK on 240 MByte volume.

You Determine how many volumes exist in your PC, and what size they are. You can have as many as *24 volumes*, and make each one exactly the size it needs to be.

Set-up is menu driven and as simple as *"How many do you want"* and *"How big should this one be?"*

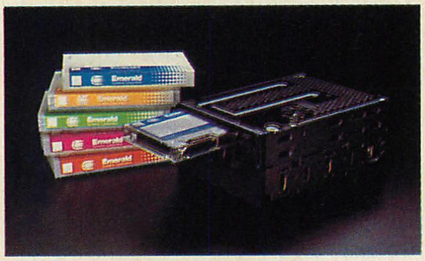
Integrate your existing hard drive into your new sybsystem. Emerald's Disk-Meld technology makes it possible for your XT's 10 Mbyte, or AT's 20 Mbyte drive to become part of a single large volume. For example, if you have an AT with a 20 MByte drive and an Emerald subsystem with a 70, you can use *all* your storage as a single 90 MByte volume. Disk melding makes it easy to combine Emerald drives with each other or with your existing drive to get a subsystem with the storage capacity you need.

Operating System and Network flexibility is yours for the asking. DOS 2.X, and 3.X will get you started. But, your Emerald subsystem can also support multi-user operating systems such as XENIX, VENIX, QNX and PC/IX and networks such as Novell, Sytek, Ungermann-Bass, 3 COM, X-Net, 10 Net, DNA Systems...

Additional Features include password security, 30 millisecond average access time, *automatic retreat to a safe landing zone* in the event of power failure or shutdown, and a long list of PC and AT compatible micro computers.

High performance 1/4" tape backup

60 MBytes in 12 minutes is *FAST* backup, but there's more. If your files are larger than 60 MBytes, Emerald's Backup and Restore Utility (BRU) software will automatically break your file into 60 MByte sections and prompt you for a new cartridge. Of course, restoring is just as easy.



Compact tape drive fits in the AT's front panel expansion space. 60 MByte cartridges are certified for high performance and supplied with color coded labels.

Emerald subsystems were designed for the PC, AT and compatibles such as the AT&T 6300 and Compaq DeskPro.

Menu driven software makes it simple, even for novices, to backup or restore exactly what is needed, and no more. Choose one or more files that were modified after a *Specified Date and Time*, one or more *Specific Files or Directories*, or *All Files and Directories on a DOS Logical Volume*.

Restore data on a different micro if you like. Backup up your company's Emerald subsystem in Portland, Maine and ship the tape to your office in Los Angeles. Because of the defect mapping technique used on Emerald hard disks, the subsystem in L.A. will import your data error free.

Special defect mapping technique allows data to be restored on subsystems other than the original source.

The BRU software *automatically checks, and adjusts to, the defect map* of every Emerald subsystem before restoring data to it.

IBM PC, XT, AT, & PC/IX™ International Business Machines Corp.—AT&T™ American Telephone and Telegraph Corp.—Compaq & DeskPro™ Compaq Computer Corp.—Ungermann-Bass™ Ungermann-Bass, Inc. — Emerald, DiskMeld, BRU & Mainframe Storage for Micros™ Emerald Systems Corp.—UPS™ United Parcel Service.—3 COM™ 3 COM Corp.—DNA Systems™ Network Development Corp.—PC Focus™ Information

r is Yours.

Configured for today's Micros

The Physical Design of the Emerald subsystems lets you determine the configuration that will best serve your needs. Many of today's high performance micros have sacrificed expansion space in favor of compact size; others offer plenty of room for additional drives, tape units and expansion cards. Emerald subsystems provide you with the expansion ability you need. And, they're designed to allow you to continue to expand as your needs continue to grow. No matter which PC you have, there is an Emerald subsystem that will meet your needs.

Subsystems are available for the PC, AT and true compatibles in a variety of configurations.

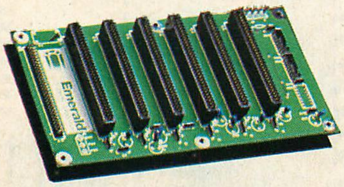
Internal Expansion is easy on the IBM AT and XT. Emerald subsystems are pre-initialized and pre-formatted—just slide the tape or hard drive you have selected into one of the existing expansion areas, plug in a couple of cables, tighten a few screws and replace the system cover. Elapsed time: 10/15 minutes.

The AT accepts 280 MBytes *or* any single drive up to 140 MBytes *and* a 1/4″ tape drive. The XT accepts any Emerald hard drive up to 140 MBytes in size, *or* the 1/4″ tape drive.

External and Portable expansion is easy and practical with the Emerald Portable Subsystems. These IBM color-matched subsystems have their own power supply and are available with hard drives up to 140 MBytes in capacity *or* with a 1/4″ tape drive.

Ordering a tape host adapter card for each of your PCs and physically moving the 1/4″ portable tape sybsystem to where it is needed will save you *thousands of dollars* over the cost of individual portables for each micro.

The portable hard drive configuration is ideal for security sensitive environments. The hard disk is password protected and the entire subsystem is small enough to be locked in a standard safe or filing cabinet.



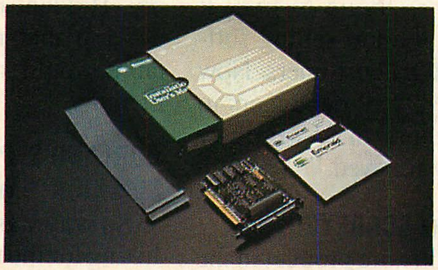
"Expansion chassis" subsystem also provides 6 additional spaces to add cards to your PC.

The 6 Expansion Slots in the Emerald expansion subsystems will be a welcome addition to many micros. If you don't have enough expansion room in your micro, or, if you've used every available slot, then one of these subsystems is just right for you. They are closely matched to the IBM PC in size and color, and have their own, built-in, power supply.

Expansion subsystems are available with drive sizes to 280 MBytes in capacity, with, or without, a built-in 1/4″ tape drive. When coupled with an AT a truly powerful computer system results.

The *real* backup procedure

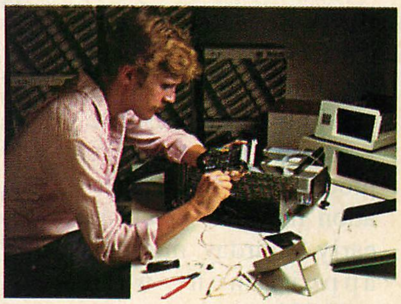
Standing Behind You all the way is the company that broke the 32 MByte DOS barrier.



Documentation, host adapter card, software and cables are included with each subsystem.

First, we provide everything needed to get you up-and-running quickly. Then, we back you up with specialists, available 16 hours a day, to help with network implementation, applications support, XENIX and technical questions, and to provide *48 hour in-and-out repair service.*

Delivery and Warranty are important considerations. Your Emerald subsystem will be shipped within 14 days of order, via UPS, and comes with a 30 day money back guarantee and a 120 day warranty. Warranty extensions are available for 1 and 2 year periods.



Fast service and fast shipping are company policies.

Users with large database applications in factory automation, CAD/CAM, accounting, medical, R&D, Point-of-Sale and many other areas are already telling their friends about Emerald. A large percentage of them are in Fortune 500 companies, and many others are on their way to Fortune status.

If your company fits one of those categories, or, if you're a smaller company with an application you thought could only be done on a mainframe or mini, pick up the phone. Call Emerald. An Applications Engineer is standing by to answer your questions, send you literature and refer you to an installed site in your area.

Let one of our customers tell you, first hand, how Emerald helped give *his* AT Power.

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Editorial Voices

The heart and soul of PC Tech Journal

Directions is usually (and hopefully) a forum about issues of interest to our audience in the computer industry. This month, it is about a small piece of that industry: us.

I have always been careful about tooting this particular horn. *PC Tech Journal* earns its keep by delivering well on its promises and not by self-promotion. We also have done well on another front: we have built an outstanding editorial staff. They deserve recognition, and I want you to meet them and know a little bit about what they do, how they do it, and why.

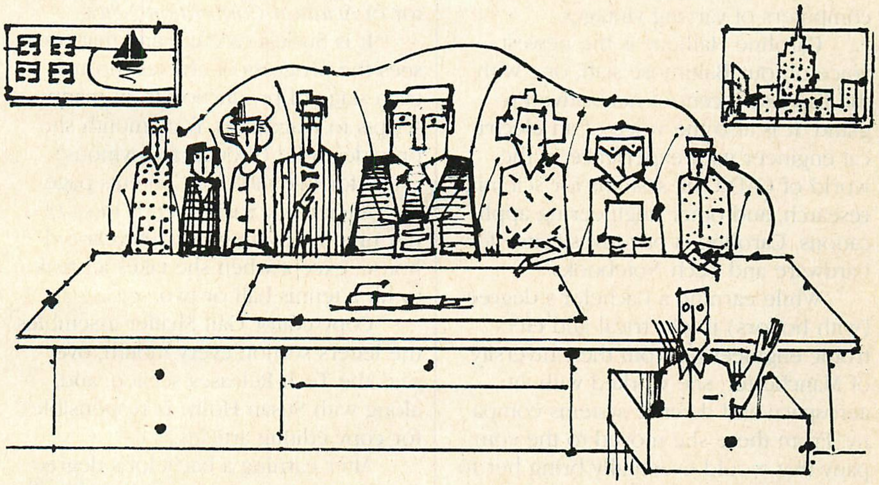


ILLUSTRATION • MACIEK ALBRECHT

EXECUTIVE STAFF

Executive editor Julie Anderson and I decide what will be published in the magazine each month, managing editor Marjory Spraycar is responsible for producing the product, and art director Ina Saltz determines how the whole effort will look.

Tooting my own horn is entirely inappropriate (although in character) so I will keep it short: Johns Hopkins University; Vietnam; Johns Hopkins; ten years, General Instrument; software development; realtime systems; microprocessors; software tools; two kids; two dogs; low-serial-number PC.

Managing editor Marjory Spraycar brought solid publishing experience to our magazine when she joined the staff in 1983. Her primary responsibility is to oversee the flow of material from idea to printed magazines.

Before taking her current position, Marjory was the founding managing editor of a successful city magazine in Baton Rouge, Louisiana. She also wrote and published a guide for that city.

Not knowing she would find steady work at *PC Tech Journal*, Marjory and her family settled in Baltimore just a mile from the Fastie household; her two children and mine attend the same elementary school. Her husband, a Medieval studies Ph.D.-turned-computer-professional, writes articles that fall into his areas of specialty. Marjory is our in-house baseball fanatic, keeping us up to date on the Baltimore Orioles.

My right hand on the technical side of the house is left-handed executive editor Julie Anderson. She began here as a technical editor, but after showing more than an ordinary measure of sound editorial judgment and working more than a little hard, it became clear that her skills would be valuable in a broader context. Julie now acts as editor in my absence, plays a key role in the editorial planning process, and supervises the technical editors.

Julie has a master's degree in computer science from The Johns Hopkins University and was project manager of software tools at General Instrument before coming to *PC Tech Journal*. In prior jobs she worked on systems software for the IBM 360 and IBM Series/1, including realtime work.

Julie lives in the country with her husband, 75 grapevines, two computer-literate sons, and two springer spaniels who do not seem to notice either the viticulture or the computers.

Just "2 hours and 17 civilized minutes" up the Amtrak rails is New York City, the home of our dynamic art director, Ina Saltz. She presides over our excellent art department, which creates the art that (a) helps explain what we publish and (b) makes us beautiful.

Ina's career with Ziff-Davis began with *Creative Computing*, as art director for the books of CC Press. Because she was already knowledgeable about and smitten with using computers to produce graphics, she jumped at the chance to fill the vacancy at *PC Tech Journal*. She got her start in computer graphics at Time, Inc., where she worked on a pilot teletext service.

Outside of work, Ina is devoted to her love of calligraphy, which she has taught for nearly a decade at her alma mater, The Cooper Union. Other loves, not necessarily in order: roller skating (a queen, we're told); and tennis (she was last summer's singles champion at her Long Island club).

TECHNICAL EDITORS

Technical editors Jeff Duntemann and Caroline Halliday and associate technical editor Dan Beale are responsible for the technical verification of all material published in the magazine.

Jeff Duntemann is our investigator for PC/mainframe issues and graphics. He is the proud new author of *Complete Turbo Pascal* (Scott, Foresman), which he adds to an already long list of

published articles on both computer topics and science fiction.

His undergraduate degree from DePaul University reflects his abilities in the arts and sciences: a summa cum laude B.A. in English with electives in physics and calculus. Before joining the staff in early 1985, Jeff worked for the Xerox Corporation, most recently as a senior programmer/analyst.

Jeff and his wife live with two Bichon Frises (they insist these are dogs). And, as could be expected from an inveterate hacker (he wears the badge proudly), Jeff has a houseful of computers of varying vintages.

Caroline Halliday is the newest voice on our Baltimore staff, one with the flawless accent of her native England. It is also the voice of an electrical engineer with experience in the world of CAD/CAE, systems for scientific research, and other engineering applications. Caroline is our investigator for hardware and Tech Notebooks.

While earning a bachelor's degree (with honors) in electrical and electronic engineering from the University of Manchester, she worked with an aerospace and defense systems company. From there she moved to the company that would eventually bring her to the United States: Thorn EMI Malco, a manufacturer of proprietary electronic equipment used in the access control, vending, and identification fields of magnetic card-based systems.

After leaving Malco she founded High Tech Aid, her own consulting company offering engineering advice and technical documentation of engineering projects. Caroline and her engineer husband are enthusiastic residents of the U.S.A., but find visits to Britain necessary to replenish their tea supply.

Associate technical editor Dan Beale arrived at *PC Tech Journal* in August with a shiny new degree in math and physics as well as a resume that described him as a microcomputer enthusiast since the age of 13, a journalist, and a quick learner. "I'll surprise you," said the resume.

Fair warning. He now has responsibility for articles dealing with many systems aspects of the PC family, and he would probably admit that his knowledge of computers has increased exponentially since he joined us.

Raised on a farm in Ohio, he graduated second in his high school class of 240 and held an Ohio Board of Regents scholarship at Oberlin College. Dan is particularly fond of eating peanut butter and reading technical manuals.

COPY EDITING

Three staff members work to guide our content—word by word—from manuscript to magazine: Susan Holly, Gail Shaffer, and Kathleen Peddicord.

Senior copy editor Susan Holly came to *PC Tech Journal* with two strong sets of credentials: bachelor's and master's degrees from Indiana University's School of Journalism and publishing experience in another special interest field, aviation. Before her current position she was acting managing editor of *AOPA Pilot*, a magazine for aircraft owners and pilots, and production editor of *Aviation Convention News*.

It is Susie's careful hand that oversees the progress of articles through each stage of production from manuscripts to magazines. Each month she provides solid (though anonymous) prose for the Table of Contents page.

After work Susie spends most of her time renovating her 100-year-old house, except when she takes a break to hit a tennis ball or two.

Copy editor Gail Shaffer assembles the letters section every month, oversees the Tech Releases section, and, along with Susan Holly, is responsible for copy editing articles.

After earning a bachelor's degree in English, she became publications director and editor for the Home Builders Association of Maryland, where she was responsible for four publications.

Gail puts us all to shame in the area of physical fitness: no one here could come close to beating her in a game of racquetball.

Kathleen Peddicord came to us with a lot more than most newly graduated college students: she had served an internship with a monthly consumer magazine. That experience, her ability to learn quickly, and her degree in English have contributed to our efforts to publish an error-free publication.

Kathie is responsible for reading galleys and other stages of proof for typographical errors; she also gathers material every month for the Calendar page and participates in the compilation of the Tech Releases section.

After growing up in the country outside Baltimore, Kathie now makes her home in the city, where she is closer to the harbor and a newfound interest in sailing.

ART

Two important behind-the-scenery players are Sharon Reuter, associate art director, and Sandra Ray, assistant art director. From their offices in New York, they work closely with our copy department in Baltimore.

Sharon has solid magazine experience as an art director. Before joining us she was the art director of *Telemarketing Magazine*, a monthly magazine in telecommunications, and before that at *Fairfield County Magazine*, a regional magazine for that Connecticut county. Her B.F.A. degree in advertising art is from the Paier School of Art in Hamden, Connecticut; she was named the best advertising student in her class. Sharon's appreciation of aesthetics finds another outlet on weekends: she often attends classic car shows in her 1964 turquoise Chevy Corvair.

Sandra Ray was an art assistant in the reprint department at Ziff-Davis before joining us. Her degree is from Syracuse University's School of Visual Communications. Outside of work, Sandra is a photographer, specializing in portraits and weddings.

ADMINISTRATION

To many authors and readers of *PC Tech Journal*, our administrative assistant Paula Lamberti is the voice of the magazine. She oversees all administrative details, handles telephone calls, and sees to it that the office is run in an organized, professional way.

After graduating from Ohio State University with a degree in psychology, Paula worked for two years in London as a secretary for the U.S. Embassy in the Department of Commerce.

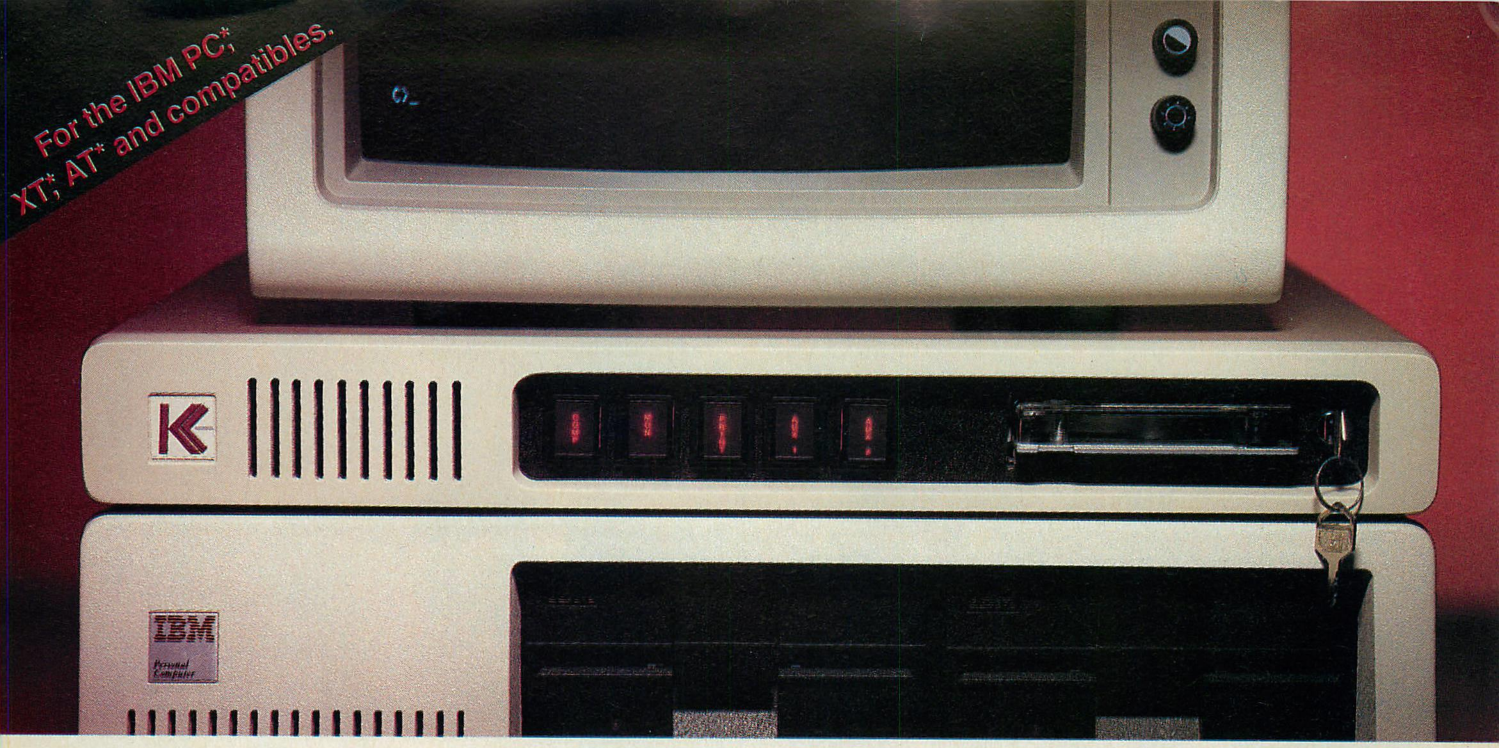
Paula is the only member of our Baltimore staff to ride the rails to work; she spends the half-hour commute indulging one of her talents: needlework.

Carole Autenzio's role as an editorial assistant is directly involved with the magazine's greatest editorial interest: developments for the PC. She maintains our relationships with vendors of PC-related products, tracking and organizing all press releases sent to the magazine. She obtains copies of products for review and keeps up to date on a product's availability and status.

Before joining us, Carole was the office manager for a group of three small companies involved in manufacturing and selling air conditioning systems in computer environments.

A lifelong resident of Baltimore (with a short time out to live in Paris), Carole now lives in the same Baltimore row house she grew up in.

I can't say enough good things about the people who work on *PC Tech Journal*. Well, maybe just this: I love to come to work.



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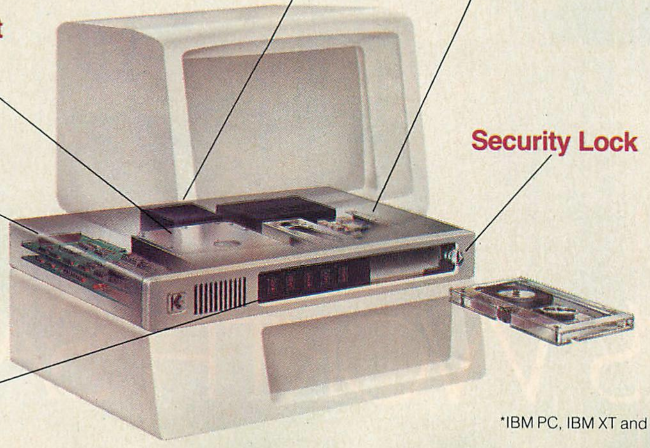

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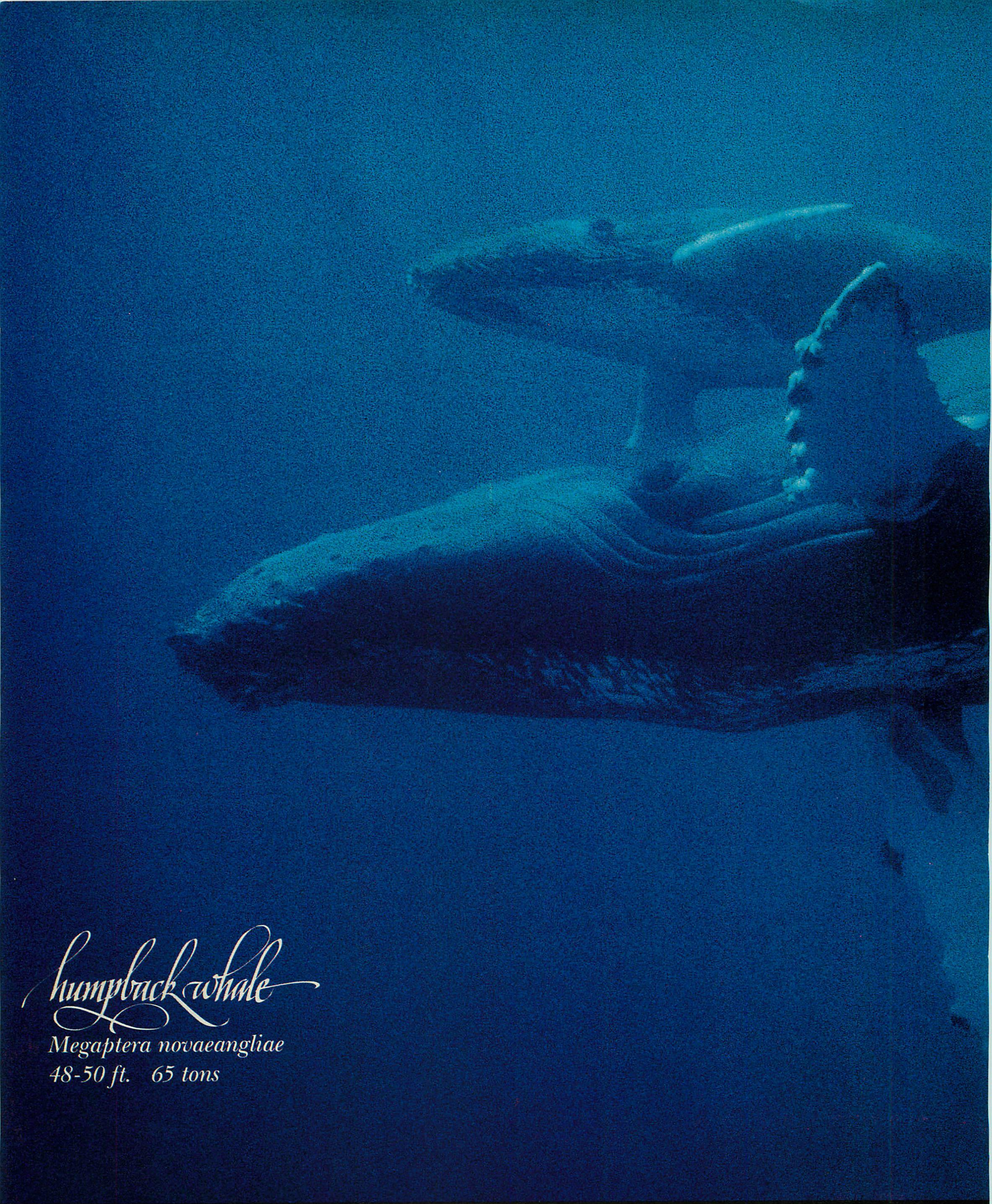

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```
make.c
int       handle = 0;

main (argc, argv

int            argc;
```

```
fsa.h
#include "..\include\ctype.h"

typedef  struct
{
   short    action,
            state;
} Fsa;
#ifdef   FSA_MAIN
Fsa      fsa[][8] = {/* Alphanum     Co

/* State 0. */          0, 2,        10
/* State 1. */          10, 0,       10
/* State 2. */          0, 2,        1,
/* State 3. */          0, 5,        11
/* State 4. */          0, 4,        0,
```

```
makefile.h
/**
 **            makefile.h:
 **
 **        This is the definitions fil
 **   Hopefully, it won't be unreasonab
 **   that have been written.
 **/

typedef struct cmd_struct
{
   char         *cmd_text;

   struct cmd_struct *next_cmd;
} *Cmd_Ptr, Cmd;
```

Mismatched open parenthesis.   Line: 11   Col: 17   2:17 pm

A TYPICAL BRIEF SCREEN

Notice there are three windows on the screen simultaneously and each one is viewing a different file. The mainline of a C program is visible in the uppermost window; the programmer has run a syntax checking macro which found a mismatched open parenthesis in the arguments to the mainline. The other two windows show header files containing information crucial to the design of the program. BRIEF can have an unlimited number of windows and files accessed simultaneously.

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COBOL CONSIDERATIONS

Being the owner of a company that develops custom software for the PC, I enjoyed your series of articles on COBOL ("COBOL Performs," Ted Mirecki, June 1985, p. 58; July 1985, p. 111; August 1985, p. 107). I was particularly interested in your findings regarding the product offerings from Micro Focus and Realia, since we are currently developing systems in both languages. Because our experiences during product development using these two compilers have led to different findings on some points, I thought I would share them with your readers.

Concerning the Micro Focus compiler, we were told by Micro Focus that future copies of Professional COBOL would be copy-protected (ours were not) using a scheme that is similar to SuperLok. This explains why two copies of the compiler are supplied. We were also told by Micro Focus not to use Professional COBOL on a floppy-based system, and through experience have found this to be good advice. Anyone wishing to develop applications on a floppy-based system using Micro Focus products should use the Level II COBOL and Animator purchased as separate products (Level II code can be recompiled at a later date using Professional COBOL without modification).

Whether or not a programmer will warm up to Professional COBOL's editor will probably be decided by his background. Programmers who are accustomed to SPF-type editors will find this editor clumsy, whereas, control sequence veterans, such as users of BRIEF, will find that some powerful features, such as windowing and macros, are missing. The editor definitely is designed to be user-friendly, which helps novices to get a fast start, but as you approach the peak of the learning curve, you find, as one programmer put it, that "Micro Focus is killing me with love!" The editor does have a lot of good features, most notably the easy access to copy files as mentioned by Mr. Mirecki. Hopefully Micro Focus will incorporate the use of Micro/SPF into the Professional COBOL environment as they have done with their other product offerings, thereby giving the programmer the opportunity to make a choice.

Mr. Mirecki makes light of the fact that the Forms screen painter does not allow the programmer to assign mnemonic-oriented names to screen fields. As good as Forms is at building screens, the product is made almost useless by Micro Focus's oversight in this area. Since changing a screen layout also changes the screen's field names, extensive program editing could be required to achieve a successful compile after a screen change, and if the programmer wishes to modify the copy file containing a screen layout to use meaningful names, the modification process must be repeated every time Forms is used.

With the exception of a limited DOS interface, some operations have to be accomplished by loading .BAT files; designing systems to be run using the Professional COBOL Run Time System (RTS) presents no major problems. One of the best features of the RTS is an alternative to the Standard Accept/Display method of screen handling that is extremely fast and powerful.

One point that Mr. Mirecki and I agree on completely is the Animator debugging tool. It is the best I have seen.

Since Mr. Mirecki stated that COBOL is for applications developers and must be judged accordingly, I was surprised to see that Realia COBOL was judged unacceptable, copy protection not withstanding. Applications developers are concerned with speed, efficiency, and productivity, all of which Realia COBOL addresses. Additionally, I doubt if a serious applications developer would be working on a floppy-based system for any extended length of time, especially considering the falling hard disk prices of today's market. As such, the amount of disk swapping or the size of the compiler is not relevant to a review of COBOL compilers.

Although not having copy protection would be preferred, the copy protection of the product has not caused us any problems. I do agree that Realia's screen handling is inadequate (unless compatibility across machines is a primary concern) and we use a screen generator in place of the standard Accept/Display method.

Even though Realia is targeted at companies who would like to download the development of mainframe systems to PCs (hence the IBM VS COBOL compatibility) I agree that considering the price, a language reference manual should be included, although most of its target market is probably well stocked with these manuals.

In spite of the negatives pointed out in the article, Realia's runtime and compile speeds are refreshing for a COBOL compiler. Additionally, the DOS interface is excellent, and provides access to DOS function calls that would normally only be available to low-level language programmers. These points, plus Realia's ability to utilize path names that allow a programmer to better organize and utilize his hard disk, make Realia a very strong candidate when choosing a COBOL compiler.

John C. Noland
John C. Noland & Associates
Westminster, CA

We have been looking forward to your August issue with great anticipation even though Ted Mirecki has been pretty tough on the COBOL compilers he has reviewed through the series.

As a manufacturer of COBOL compilers for the PC we are supportive of promotional efforts and press directed towards the language and feel that reviews such as these should present the products with their best foot forward.

Our "foot," as reviewed in the August issue, was presented without a shoe. There were two major product oversights that are in need of correction and two general gripes about the nature of the review of mbp COBOL.

The mbpCLEAR utility was simply overlooked in the review. This utility, which is included with the version 9.0 COBOL in *PC Tech Journal*'s possession will clear the mbpSIM module from memory thereby freeing 44KB of disk space for other needs. The article indicated that mbp will remain in memory until the system is reset—this would not be a desirable feature.

The article indicated, both in text and in chart form, that mbpCOBOL does not support DOS path names. This is a very important feature. It is an absolute necessity for intelligent system design and that is exactly why mbp COBOL fully supports DOS path name conventions. We include a statement of this support in an advertisement we run in your magazine.

DOS path names are supported by mbp COBOL during execution in both variable and static file assigns. Although path names cannot be specified during compilation, the compiler may be invoked from any directory in the system. The source program and the compiler do not have to reside in the same directory as indicated by the review.

We feel that it is important to point out that due to the nature of COBOL, it is a language "more for applications developers than for hobbyist programmers. Accordingly, COBOL compilers should be judged a little more strictly . . ." Furthermore, the article is targeted at the "serious applications developer." Why, then, was the review based on using a floppy-disk system?

The use of hard-disk systems, as recommended by the manufacturer, would result in less inconvenience and time spent in program development, and it also would allow the compilation of large programs that seem to be important for the developer.

Also, one of mbp COBOL's best features (our screen management system) only had one short paragraph dedicated to it. Micro Focus somehow received more attention for its screen system. This seemed to lend less credibility to the review as it appeared as more of an advertisement for Micro Focus than an accurate review of which product's features were more capable. The review of Micro Focus's screen system spent a great deal of time discussing the ease with which a developer can fill up

working storage with unnecessary display data. Mbp has spent the past several years attempting to keep this bulky information out of the source code—a feature completely overlooked.

We hope that this short critique of an otherwise fine review series will be meaningful to *PC Tech Journal* in some way. Our customers noticed the review and are writing in on their own. This seems to indicate that the magazine continues to address an informed and growing readership and is truly one of the industry's finer publications.

Michael L. Hicks
mbp Software and Systems Technology, Inc.
Oakland, CA

The mbpCLEAR utility was overlooked in the review because it was overlooked in the documentation. I hesitate to run any undocumented program with a name like that; after all, it might be a disk formatting utility.

This utility does clear the runtime system from memory, but releases that memory for other uses only if the runtime was the last resident program installed. If other resident programs were installed after it, the cure becomes worse than the disease, because a subsequent invocation of the runtime will chew up another 44KB of memory.

The sample program sent with your letter does indeed demonstrate that mbpCOBOL programs fully support path names at runtime. The use of path names is not documented, however, and I could not get them to work in my test programs, no doubt through some error on my part. I regret the error and sincerely apologize for it.

The review notes that the lack of path support at compile time is an inconvenience, but nowhere does it say that the source and compiler must be in the same directory. But how do you invoke the compiler "from any directory in the system?" I found that all compiler overlays must be in the current directory of the default drive, and setting a DOS path does not help.

All compilers were tested on an equal footing, on the same system. I chose a floppy-disk system because the compilers tested earlier were the smaller ones that could well be used on such equipment. All the compilers were tried on a hard disk, and there mbp COBOL ran much better, but so did the others. In fact, because of the lack of compile-time path support, mbp COBOL did not benefit as much as some others.

—Ted Mirecki

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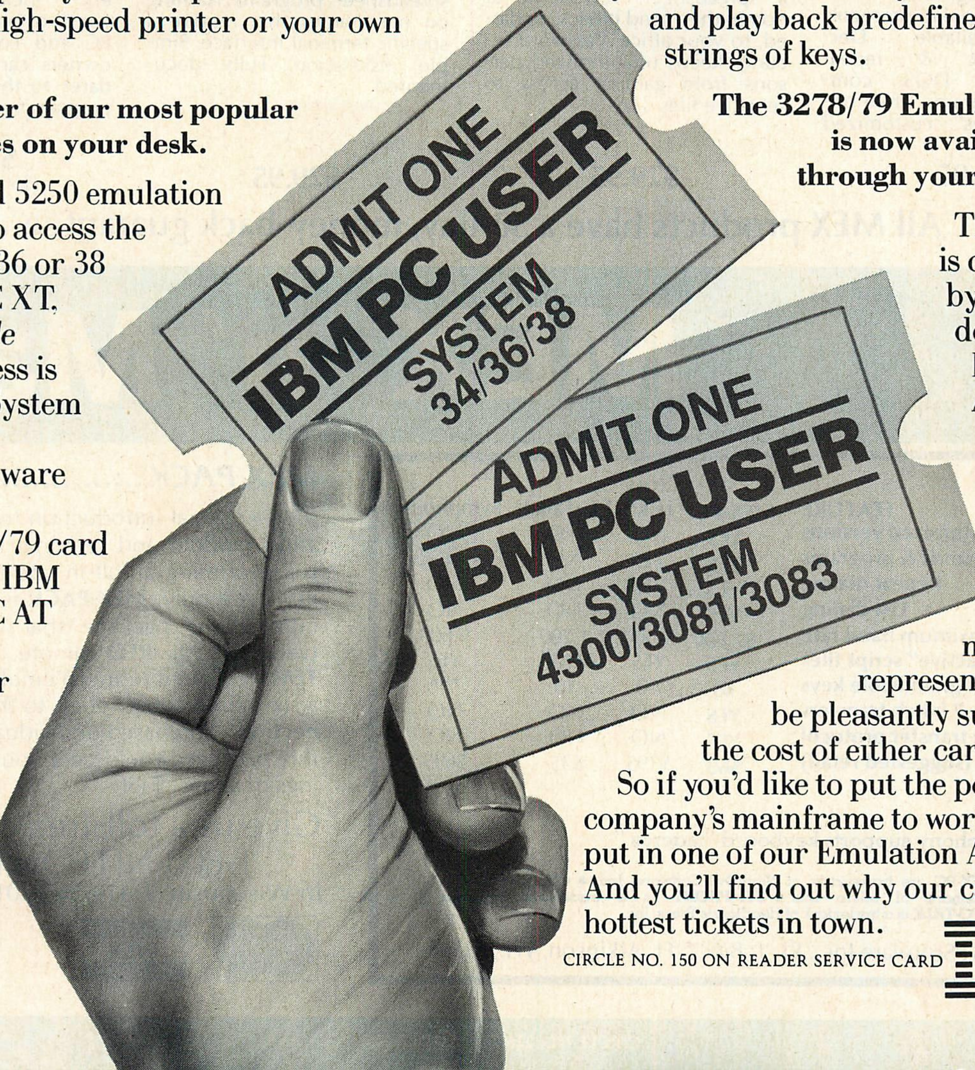

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DATAFLEX REFLECTIONS

Congratulations on embarking on a much needed comparison of database programs ("Evaluating Data Managers as Development Tools," Julie Anderson, August 1985, p. 46) and for starting off with a gem like DataFlex ("A Data Manager for Diverse Environments," Chris Christian, August 1985, p. 52). If the high quality of the articles continues the series should become a classic. The depth of the article was astounding; I have been developing in DataFlex for more than a year now and I even picked up a trick from your article.

It is my opinion that DataFlex will revolutionize the applications software market by enabling the software developer to provide a much higher level of functionality than previously possible. My use of DataFlex has enabled me to provide a new generation of property management software that entirely does away with the property, tenant, and vendor numbers used by ordinary property management programs to access data.

In the interest of further educating your readers, I must point out that your example of the tasks involved in adding a field was, for most cases, unnecessarily complicated. When adding a field to a file in a DataFlex application, *never* add the field in the middle of the record, unless there is some reason that forces you to do this. There is no reason why middle initial must come between first name and last name in the record. Add it to the end. Since DataFlex blocks out records to some standard record sizes, adding a field will most likely not increase the record size, and if this is the case, all of the cautions mentioned in your article when adding a field become unnecessary. There will be no field number changes for the other fields, thus no need to recheck file relationships and indexes, and no need to write the file out to ASCII and read it back in again. Granted, there are occasions when what you describe is necessary, but they are infrequent.

In addition, your description of the use of the CLEAR key is inaccurate. SAVEing a record will clear the windows for you; it is not necessary to use the CLEAR key. The CLEAR key restarts data entry when you want to dump the data on the screen and start again, or when you have FOUND a record and wish to FIND another one by entering a few identifying characters and pressing the FIND key. Also the SUPERFIND key is used to FIND records in a related file

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Large Memory Model: Manx Aztec C86 supports programs and data of any size. Global data has a max size of 64k.

Intel Object Option: Interface to software that requires Intel object format, such as PLINK86.

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once you have FOUND the main record. For example, use FIND to find a tenant, then when the tenant is on the screen, use SUPERFIND to find the first tenant transaction.

It is not true that DataFlex lacks a provision for converting between character strings and dates. The user must simply MOVE the date type of variable to the string type of variable, or vice versa. Conversion is automatic.

And, DataFlex *can* test for the existence of a file. An indicator, SEQEOF, will be set to true if DIRECT_INPUT FILENAME is executed and FILENAME does not exist. FILENAME can be any type of file. I use this method to test for the existence of a DataFlex program before trying to chain to it.

DataFlex provides FIELD-level locking, not just RECORD-level.

One very impressive characteristic of DataFlex is its multileveled approach. In level 1, a single file application can be generated by a new user with no knowledge of the DataFlex programming language, by using AutoDef and Query. At this level, the source code for your data entry and reporting modules is generated for you, and can be modified, leading you to Level 2. Level 2 involves using the DataFlex language to handle more complex multifile applications. Then there is Level 3, modification of FMAC to create your own use of the Pascal source code library to DataFlex, allowing modification of the DataFlex language itself.

In addition, DataFlex publishes an applications library of applications written in DataFlex. In addition to standard applications, it includes such items as a DataFlex cross-reference utility program (FlexRef), books on learning DataFlex, and extensions to the DataFlex language. There are also various user groups throughout the country. There is even a DataFlex specific magazine, although it is in Swedish.

Kaye K. Caldwell
Oakland, CA

Ms. Caldwell's caution to append fields to a DataFlex record definition instead of inserting them underscores my point that "inserting a field can be disastrous." For some database managers this is not true, which is why I choose to elaborate on the point. I do find it difficult to return to an old application only to find the data layout is not organized in any apparent order. (I have fixed a problem or two twice because the name and location of an added field did not convey its use.)

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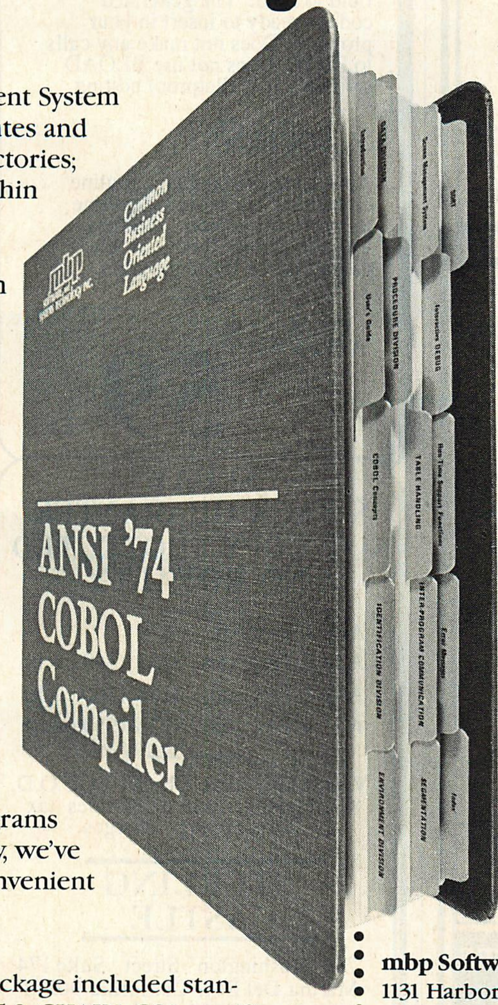

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The reader's description of the CLEAR key's use is more accurate than that implied in the review. Pressing CLEAR after SAVE is unnecessary, but doing so is harmless. Flex keys are a bit tricky at first, yet in them lie many of the functional extensions possible in DataFlex that one might not even attempt with other systems. And, MOVE does convert between data types—my oversight and, indeed, a subtlety of the DataFlex language.

Testing for the existence of a file is very important to me, perhaps because I tend to use files as system status indicators and view files as permanent, global variables. DataFlex has no built-in function to test for the existence of a file. Opening the file for input and then testing/trapping for errors is a very BASIC-like method of performing the file-test task. But to me it is a form of negative logic. Open the file, check for errors; if there are none, the file exists. On some older systems, opening a file that is set read-only will result in a fatal error and abort the application. I avoid such systems now that better ones are available, but the paranoia remains.

Ms. Caldwell's observation of DataFlex levels is astute. How nice for a user to be able to learn a system by degrees that relate directly to his understanding of the system's inner workings.

—Chris Christian

I disagree with three statements made by Chris Christian: "DataFlex seems to be a product that would meet the needs of most applications developers . . . The nature of DataFlex encourages modular applications designs . . . DataFlex deserves a favorable consideration as a development system."

The main problem with DataFlex, as pointed out by your author, is that it numbers everything and never lets the application know which number is which file and which field; and there simply is no data dictionary. You *cannot* build independent modules in DataFlex because there is no way to let one module know the changes you have made in an independent way. You must change the code in all applications (there is no library or copy facility, so for any changes you make you have to manually propagate and recompile all affected programs).

Here are a few things Mr. Christian did not mention in his review:

- DataFlex accepts letters that are entered into a declared numeric field.
- A user is not able to directly erase or delete a data file from DataFlex's own

internal file directory of his applications and databases.

- Even though it is advertised as being able to handle up to 18 digits, if you enter more than 10 in a numeric key field, DataFlex hangs.
- The access method is proprietary, so there is no way to retrieve (and/or update) database records in a programming language.
- Representatives of Data Access, the provider of DataFlex, are impolite and sometimes incorrect on its help line.
- Even though DataFlex is supposed to be a multi-user package, every user must have a copy of every executable file in his own personal workspace. According to DataFlex, it is impossible to have one central copy of the read-only program code for, say, an MP/M or NStar system accessible to all users.
- Because DataFlex is interpreted you might expect to debug your programs more easily because you could have access to runtime values. Not true, and worse, the error messages are as cryptic in this interpreted system as in any compiled one.
- DataFlex is not a database system according to any definition I know. You do *not* define all the elements you want to keep track of and then define separate views as the applications evolve. Rather it is a limited file system in which there can be up to six one-way relations between the fields of any two files. DataFlex has no knowledge of a system's overall data elements, so it cannot detect duplicate or inconsistent definitions. Further, it defines some attributes in programs instead of in data definitions.
- DataFlex does not support windows. In this system the term is used as a synonym for field.
- Compile time is long, sometimes more than 20 minutes on a PC. Since you have to recompile after every change, one spends a great deal of time in front of the computer.
- In order to clear the screen, DataFlex writes a blank into every position.

I have overcome many of DataFlex's shortcomings, most often stimulated by Data Access's determined insistence that it was impossible. I have added a data dictionary, made DataFlex databases accessible by programming languages, eliminated the ponderous menu system, maintain only one copy of the programs in one central account, and found a way to erase a DataFlex database. I also have developed a front-end that generates DataFlex programs so that one does not have to try to plow through the supplied documentation.

Data Access Corporation is not market-driven, so I can't wait to read your reviews of other, *real* database management systems that might be appropriate for systems development.

Stan Rifkin
McLean, VA

Mr. Rifkin's letter points out an important aspect of PC Tech Journal*'s series comparing database managers. The primary focus of the series is to compare how suited different products are as tools that sophisticated developers can use to create one standard application (the editorial system). The application is to be used by a nontechnical end user. With this in mind, the ease or difficulty that a developer may experience in creating the editorial system with a particular database management program such as DataFlex deserves comment. The development process is not, however, the only measure of a database manager. If we viewed these products as*

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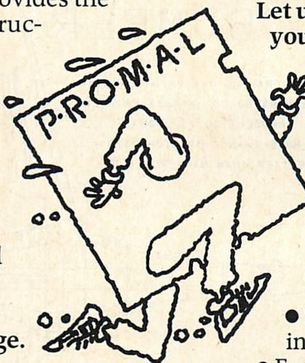

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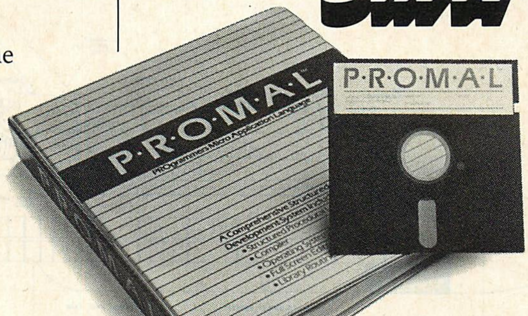

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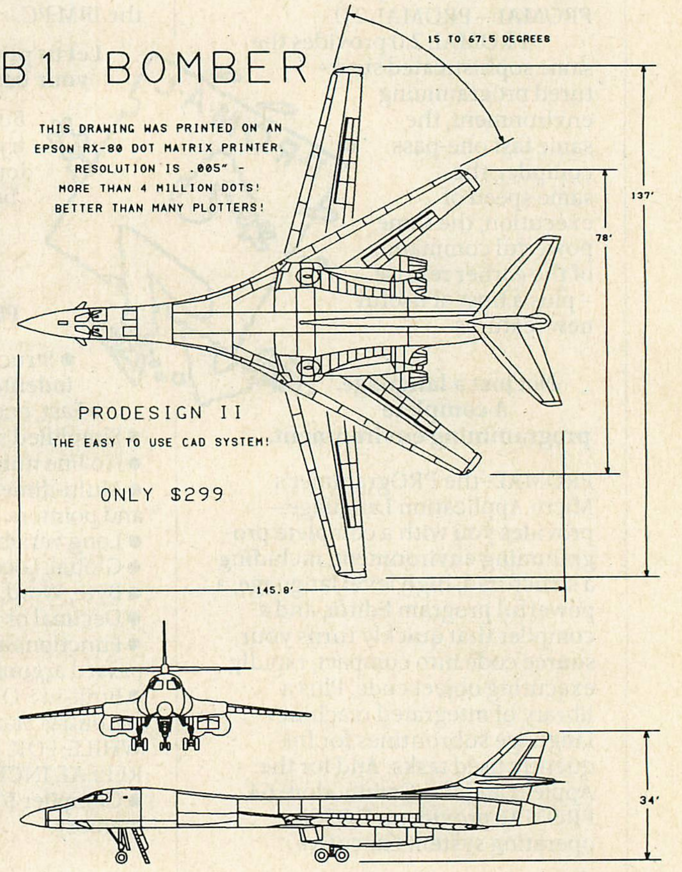

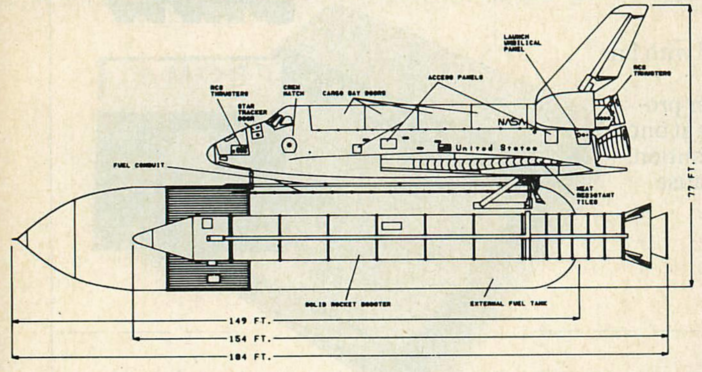

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productivity tools, even programmer productivity tools, the basis for the comparison would be different from the template developed by PC Tech Journal.

Several of Mr. Rifkin's comments lead me to conclude that his experiences with DataFlex are on a version earlier than that used for the review. With version 2.1b, screen displays, for example, are nearly instantaneous, even on a floppy-disk system. I haven't experienced other problems he mentions, such as that with the Query processor. Version 2.1b does support type-ahead, and so on.

It is true that compile times with DataFlex are very long—but that is certainly one of the considerations I have in mind when I say that DataFlex encourages modularity. Another is the compiler directive that allows external static code to be included from other files into the file being compiled. DataFlex rewards careful planning. For some customers or applications this may not be possible. While compile times are long, the trade-off is that once compiled, a program can run on any DataFlex supported system, including multiuser systems. The review, however, does not evaluate multiuser experience.

Every DBMS program has strengths and weaknesses. I have endeavored to state those I found with DataFlex so that it can be compared with others in the series. The DataFlex product can be used to implement the tasks required for the sample application, and as such it does deserve consideration as a development system. My understanding is that the reviewers will make the best case for each product and support their claims with the measures PC Tech Journal *requires in the comparison template. Readers then pick their own winners.*

—Chris Christian

SUSPICIOUS BUBBLES

Thank you for including the Hicomp 504A Bubble Drive in your evaluation of bubble memory boards in the May 1985 issue ("Bubble Boards," Don Awalt, p. 123). Please let your readers know that ADIC has acquired Hicomp and that we are continuing to manufacture and market this product line.

We would like to take this opportunity to correct errors that appeared in the article. First, your article states that the Hicomp 504A only emulates floppy disks. The 504A actually emulates either two floppy disks or a single hard disk. Second, you are correct that the DISKCOPY and DISKCOMP commands do not work; given the cost-per-bit of bubble memory, we felt optimal use of the bubble was most important and configured the bubble as dual floppy disks. This keeps us from implementing these commands, but lets us make the entire bubble available to the user.

We also are suspicious of the article's benchmark results because they seem inconsistent. For example, the results for single sector random read show obvious problems with the data.

One last point: Mr. Awalt criticizes us for including too many switches on the board, but fails to mention that 11 of the 18 switches included are for configuring our RS-232 option. The other seven provide our users with tremendous flexibility in configuring board address, bootability, and storage type.

We agree with Mr. Awalt that bubble memory will continue to be a favored solution for PC installations in harsh environments.

Andrew J. Blackstone
Advanced Digital Information Corp.
Redmond, WA

Good luck in your association with Hicomp. I suggest that you include DISKCOPY and DISKCOMP support for diskette emulation because these commands are used heavily by PC owners who do not have hard disks.

For more information on the benchmarks used with our disk/disk emulation product evaluations, refer to "Fixed-disk Benchmarks," William J. Hunt, November 1984, p. 64.

I do not dispute the amount of flexibility the Hicomp board gives its users, only the use of board switches to do it. Manipulating switches requires the user to open the PC chassis for reconfiguration and perform work normally done by the dealer. Board configuration through software and retained in nonvolatile memory (of which a bubble memory board has a lot) enables the manufacturer to supplement installation documentation with intelligent user assistance. Refer to the PC/AT Setup program for an example.

—Don Awalt

WHERE'S THE EOF?

In the "Letters" column of *PC Tech Journal* (May 1985, p. 14, and August 1985, p. 16) discussions were presented about a DOS redirection bug. The bug is that DOS does not do anything with end-of-file (EOF) marks that are at the end of files. I would like to offer you some ideas that support the notion that this situation is not a bug and the DOS redirection does operate correctly.

Redirection is a general process. That is, the devices that are used are unspecified as far as DOS is concerned. The devices (or files) are specified by the user. Redirection says where information should go or come from, not what to do with that information. Only the user can know the consequences of any specified redirection.

In a directory listing of a text file that contains an EOF mark, the length of the file includes the EOF mark. The EOF mark is part of the internal structure of a file. The software that created the file or is to read it is responsible for the contents of any file. Redirection moves entire file units. The contents of files are variable and cannot be changed by the redirection process.

To illustrate the process of appending two files using redirection, create the following two files:

File TEOF1.TXT
TEOF1.TXT was created by EDLIN and contains an EOF mark at the end. An EOF mark follows the CRLF here →

File TEOF2.TXT
TEOF2.TXT was created by EDLIN and contains an EOF mark at the end. An EOF mark follows the CRLF here →

Now create TEOF3.TXT by executing the command:

TYPE TEOF1.TXT > TEOF3.TXT

File TEOF3.TXT
TEOF1.TXT was created by EDLIN and contains an EOF mark at the end. An EOF mark follows the CRLF here →

Now append TEOF2.TXT to TEOF3.TXT with the command:

TYPE TEOF2.TXT >> TEOF3.TXT

File TEOF3.TXT
TEOF1.TXT was created by EDLIN and contains an EOF mark at the end. An EOF mark follows the CRLF here →

TEOF2.TXT was created by EDLIN and contains an EOF mark at the end. AN EOF mark follows the CRLF here →

In this example the EOF marks stay with the files. The final TEOF3.TXT will contain two EOF marks, one at the end of the TEOF1.TXT text and one at the end of the TEOF2.TXT text.

In a second example of appending files using the COPY commands, issue the following DOS command using the above test files:

```
COPY TEOF1.TXT + TEOF2.TXT C2.TXT
```

In this example the EOF marks will be manipulated. The final appended file, C2.TXT, will contain one EOF mark at the end of the TEOF2.TXT text. The EOF mark that was at the end of the TEOF1.TXT text was removed.

The meaningfulness of files that contain various special characters is up to the user or applications developer. Using redirection to append files with EOF marks will not change the content of the files, and the EOF marks will remain where they were in the original files. Using the COPY command with its various options allows EOF marks to be manipulated and files to be appended, with and without EOF marks.

The DOS redirection or piping processes do not add or subtract characters in any file. DOS filters remove the EOF mark at the end of an input file and do not add an EOF mark to the end of an output file. The DOS COPY command allows EOF marks to be manipulated. Though the interaction of these processes is complex, these processes are not in error. In some cases, however, undesirable results can be created with these processes.

William Herron
San Diego, CA

In an environment as versatile as PC-DOS, one man's bug may well be another man's feature. EOF markers are parts of DOS text files (binary files do not have them) and redirection is not intended to interpret file contents. Seen from this perspective, it is entirely proper that EOF markers are moved along with other files when multiple input files are redirected to a single output file. When file concatenation is the desired output, DOS COPY is the proper way to proceed. Thank you for sharing your insight.

—JD

WRAPAROUND MODE

In "Switching Modes," by Guy Quedens and Gary Webb (August 1985, p. 163), the authors mention that the PC/AT contains an "unexplained hardware gating switch on line A20 between the iAPX 286 and the bus" and that IBM has "given no clue as to its purpose." Your readers might be interested to know that this gate was included due to an incompatibility between the 8088 and the 80286 in real mode. It is possible to set up a segment:offset combination on an 8088/86 that results in an address greater than the 1MB limit if you use a segment value greater than F000 and a big enough offset. For example, F600:FFFF would generate address 105FFF—greater than 1MB. Because the 8088 has only 20 address lines, this address would "wrap around" and come out as 05FFF. However, the 80286 has 24 address lines and so *could* generate the full 105FFF. The purpose of the A20 gate then is to ground address line A20 in the 80286's real mode to maintain compatibility with 8088/86 software that might generate an address such as F600:FFFF, forcing the 80286 to also "wrap it around" to 05FFF.

Jack Wright
Princeton, NJ

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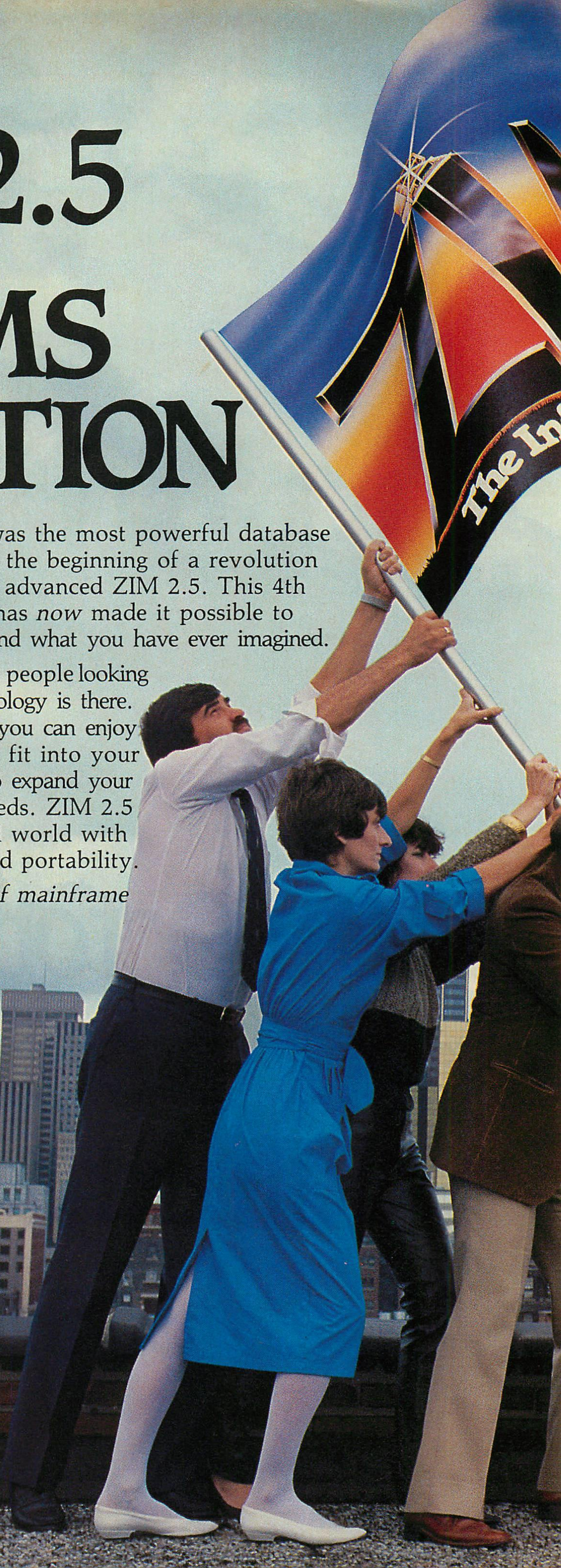
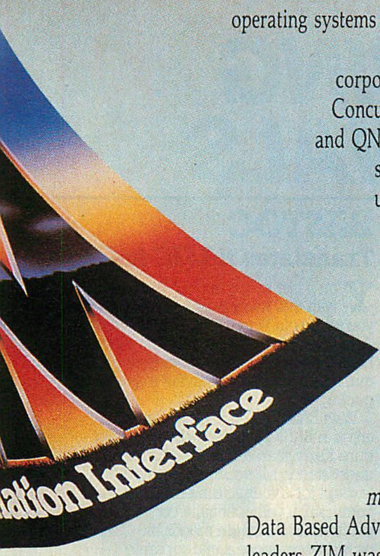
James Creane
Data Based Advisor/July 1985





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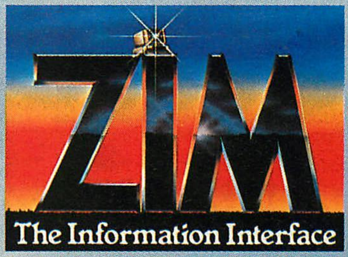
SPEED: *"ZIM has not sacrificed execution speed to gain its expanded functions in terms of existing microcomputer databases..."* James Creane, Data Based Advisor/July 1985. In comparison to industry leaders ZIM was at least 3 times and as much as 50 times faster in sorting and joining files within the database. Only ZIM can break the speed limit. ZIM's internal architecture, strategy selector, priority-driven buffering ability and implementation of a new and compact B* trees ensure that the information is delivered in the most efficient manner possible. Never again will sorting, reporting or other complex information retrievals be left as an overnight task.

POWER: *"ZIM is unique, and the source of its extraordinary power to mimic the real world springs from the way it views data. It uses an "Entity-Relationship" model of data, an extension of the relational model...(ZIM) represents and manipulates complex data with dramatic simplicity and economy of expression."* John Helliwell, PC Magazine/September 3rd 1985.

With ZIM's high-level, natural language you can build user commands implementing applications with unparalleled ease and flexibility without the necessity for additional programming tools and additional costs. ZIM's forms facility permits completely menu driven applications. This, combined with the extensive report generator, allows development of applications that can be used by any novice user. The ZIM compiler will compile complete applications leading to faster execution and preventing unauthorized access or modification. Completely compiled applications can be run with the standalone Runtime system, decreasing cost and memory requirements.

FLEXIBILITY: *"ZIM is a well-conceived, soundly implemented, thoroughly professional system. Its design evidences a strong commitment to consistency and to the goal of natural, nonprocedural user interaction... Its implementation evidences its developers considerable skill and experience."* Richard M. Foard, PC Tech Journal/October 1985.

The only limits with ZIM are those of your hardware, operating system and imagination. Now with ZIM 2.5 your database is no longer limited to a single hard disk. With ZIM, information management is a breeze. With only three commands required for all update operations. ZIM gives you unprecedented simplicity and flexibility. Features include automatic update of all indexes, multi-user support, an extensive range of validation, editing and masking facilities. Security at various levels is offered as an option. Accidents can be fatal — the UNIX and XENIX implementations of ZIM 2.5 will support audit trails in multi-user mode. A new utility is provided to use audit trails to recover the database in the event of system failure — insurance for your hours of work.



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Supports ASCII or binary, any parity, any word length, 8250 UARTs, all four Lattice C memory models, Hayes 300, 1200, 1200B and other modems.

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CDEBUGGER
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We've offered "symbolic" debuggers for some time. They can refer to program symbols — the names you give to variables, functions, etc. in your source programs — so you don't have to debug C programs by way of hex memory addresses. Now along comes a true source level debugger for programs compiled with Lattice — and at a breakthrough price.

Switch on the Cdebugger™ source display, from the beginning or at any breakpoint, and enjoy the uncanny experience of watching your source code step by, one line at a time. Or skip ahead n lines and display from there. Or browse through source from the surrounding program area — even from another file.

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Other commands display and alter memory and registers, show and replace expression values. Simple variables may be referenced directly by name. (Not local names which the compiler doesn't map.)

No list of source files need be provided to Cdebugger. It simply targets all .c files in the current directory. Cdebugger supports and automatically recognizes all four memory models. Needs 256K.

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BASTOC
Translates BASIC to C

You'd like to upgrade C, but what to do with that warehouse of BASIC routines you've carefully polished over the years? And how to face converting your famous Leviathan accounting system from BASIC, much less your Labyrinth file management package?

With BASTOC,™ a translator which takes in BASIC source code and emits pure Kernighan & Ritchie C. Our BASTOC understands Microsoft Extended BASIC (except for dynamic dimensioning and common). It will optionally convert your program into a single monolithic C function or will decompose it into separate functions, one for each GOSUB label.

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Source code of several modules of the translator and library are provided so you can tailor BASTOC to your environment if needed. And source of the entire product is for sale.

Product Code: S0370# Our Price:
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PANEL
Adds 3rd Dimension

The newest version of this premier programming tool lets you layer your screen designs with up to ten overlapping images, making it easy to background a screen with pop-up lists, help boxes, and alternate sets of input fields.

Writing your own screenware is a good way to blow completion dates and profits. Panel™ works with you interactively to set up foolproof screen displays and data entry forms rapidly. It tests your form to prove that it (and test data) behave correctly, then converts the finished work into C source code for incorporation into your application, and compilation with Lattice.

Wonderfully diverse attributes may be selected for any field — size, data type, color, of course, but also: conversion of input to upper case; clearance of existing data when new entry is started; masks for standard formats (e.g., dates, phone numbers); a choice of styles for numeric fields; phrases which fill in when their first letter is typed; multiple-choice lists from which to choose a field fill-in by cursoring a highlighted bar. Fields may be multi-lined (e.g., name and address as one field) and scrolled if larger than the screen space allotted them.

Panel builds in a user interface for keystroke movement within and between fields, and supplies extensive validation routines for checking user field entries — in source code, so you can tack on your own unique variants.

Panel's screen layouts can be assigned to individual windows under Lattice Window control. Screen designs may be dynamically loaded from file, or compiled into a program, and version 6 has optimized code to quicken display speed.

The whole package is wrapped in a monitor and keyboard customization package to tailor* your application for other equipment.

Panel. A superior productivity tool now bigger than ever.

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BTRIEVE
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If your programming still gets anywhere near the files, here's our guarantee: Nothing will increase your productivity faster than handing the filing job to a sophisticated file manager.

Btrieve™ is the best we have seen. It takes complete charge of all file indexing, reading, writing, insertion and deletion. It builds 22 commands right into the language you use in the form of functions you call to tell Btrieve what to do. The commands create, open, and close files; delete and insert records, recapturing vacated space; find records which exactly or most nearly match keys; walk files by ascending or descending key.

Btrieve's foundation is a balanced-tree indexing scheme, conceded to be the fastest search technique devised (it will find any key in a million-plus item index in four or less accesses).

Btrieve comes with interfaces to C, Pascal, BASIC, and COBOL, and the manual gives you working sample programs which demonstrate every command in all four languages. The kind of presentation which led *PC World* to exclaim "for those of us who have endured poorly written and inadequate manuals, this one is a pleasure to read."

Btrieve has mainframe specifications! A single file may have up to 24 indexes. Segments of keys may be indexed. Each index can independently accept or block duplicate keys. A record length can be up to 4090 characters; an index length 255 characters. A file may be 4 billion bytes. It can even extend a file across two drives — even two hard disks!

With Btrieve you are freed to think logically; the physical file is no longer of concern. Gone for good is all that time-wasting dickering with intricate file referencing schemes and sorting algorithms. Thinking shifts to a higher plane.

Product Code: S0650 Our Price:
List Price: **$245.00** **$199.00**

PLINK86
Size Unlimited with This Overlay Linker

Software is becoming ever more sophisticated, which means more complex programs requiring large chunks of memory. But if you use extra memory to do the job, you are counting on users to have expanded RAM, and will forego sales to those who do not.

Plink86™ is the answer. It shoe-horns large programs into small memory. First, Plink86 acts as an alternative to DOS' Link. But Plink86's overlay power is what has gained it a reputation as a miracle worker. It binds into the compiled program its overlay manager which knows how to swap modules of your large linked program between disk and memory, so that each can temporarily occupy the same memory space.

Unlike other linkers, the overlay manager acts on its own, needing no calls from the source program. Instead, Plink86's straightforward overlay description language allows you to describe your overlay structure in one place in your program — a structure permitting up to 4,095 overlays stacked 32 deep.

Plink86 can even sub-divide its linked output into multiple files for programs which must span more than one disk.

PC Tech Journal calls it "the premier linker and overlay loader that's taking over at many of the programming shops around the country."

Product Code: S0500 # Our Price:
List Price: **$395.00** **$315.00**

BASIC_C
Use Your Knowledge of BASIC to Learn C

If you're getting the message that switching from BASIC to C would be prudent, you're about to discover that it's back to basics of a different sort. BASIC is fat with hidden functions that stripped down C just doesn't have.

Gone are all those handy string manipulators like LEFT$, MID$, STRING$, etc. In C, when you reach for even simple invocations like INPUT or PRINT — well, underlying such expressions in BASIC are bulging macros which C cannot have if it is to keep its slim profile.

But now comes BASIC_C and all your old favorites are back. Over 80 routines to open and close files, field and perform conversions on file buffers, peek and poke, print using, clear screen, "instr", on error goto. . .they're all there. Some have reworked names and syntax to suit C, but all are written as one-to-one functional equivalents to the familiar features of BASIC. And they are documented one to a page in alphabetical sequence like the Microsoft manual for added familiarity. Plus a first rate chapter comparing how BASIC and C go about their tasks.

So with BASIC-C, when you're thinking INPUT, go ahead. Use it. Or LPRINT or LOCATE or INKEY. But without BASIC_C, you will find that every line of code plunges you back in the C texts to figure out how to write it. Someday you'll want to, but for now, BASIC_C will start you programming quickly at the statement level so that you can concentrate on C's larger concepts.

Product Code: S0350 # Our Price:
List Price: **$175.00** **$145.00**

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RUN/C — THE C INTERPRETER

Now Two Versions for C Rookies or Pros

RUN/C is not just a C interpreter, it's an interpreter that behaves like BASIC! Use RUN/C™'s full-screen, in-line editor to create a program. RUN it, just like BASIC. If it stumbles, just LIST it, EDIT it, add lines, delete lines, RUN it again, fix it again. It has familiar commands like LOAD, MERGE, SAVE, FILES, even TRON — and TRACE to show each time a variable changes, and a built-in profiler to report the number of times each program line is executed.

RUN/C is ideal for rapid program development. Put up code at high speed, tinker and re-arrange, try out things devil-may-care, and let RUN/C find your typos and malaprops. Bang away at tight little sections until they're bullet proof. Then hand them to the big compilers for conversion to linkable modules.

RUN/C has a treasury of functions built into the interpreter — over 100 paralleling the most used functions found in standard compiler libraries. So when and if the time comes to compile, your source code will find counterparts.

RUN/C LITE

RUN/C Lite makes a splendid teacher. The manual has not just instructions how to use RUN/C, but its 500-plus pages provide a thorough-going demonstration of the C language itself. Every feature, of C or RUN/C, is accorded its own micro-chapter. Over 100 of these chapters are devoted to RUN/C's built-in functions, and every one lists a sample program showing how it is used. These same programs are on the disk. So as you read them in the manual, you can run them on the screen, see what they do, discover why they do it. And tamper with them, try things out, see what effects your changes have.

RUN/C Lite utilizes source code only, whether created by its own editor, or from any ASCII file, such as programs you've already written or commercial libraries which supply source code. Moreover, source modules may be held separate and #included (no point replicating PC BASIC's deformities).

Lots more features: system interrupts, a shell command to invoke any operating system command without leaving RUN/C, even the ability to load a preferred editor in parallel and switch back and forth. (Occupies 180k, 256k recommended.)

RUN/C PROFESSIONAL

Sounds great, but if you're a pro, you know that source-only interpreters mean commercial binary tools are off limits.

No longer true, because now there's a new professional version of RUN/C that gives you the power dynamically to load and unload multiple binary function libraries while in its interpreter. Your code can now reach for functions in any of the professional C libraries — C-Food Smorgasbord,™ Halo™ Greenleaf™ — any library compiled with Lattice's large model.

The Loadable Libraries™ link-up lops loads of time from development work. Functions once available only *after* compile and link are at your fingertips at the front end for instantaneous testing.

Your own function archives? No difference. Compile them into a Lattice large-model binary library, and yours can be set up for RUN/C integration the same way. The manual shows how to interface a library. (Important: you need the Lattice compiler, 320k minimum and 512k recommend to fit libraries.)

RUN/C Pro adds an extra level of debugging aids. They are ingeniously installed behind a built-in function, so you can call for debugging conditionally. The called function either executes any of RUN/C's commands (e.g., LIST) or paints a menu of debugging tools to choose from, including immediate mode to display variables, single-step tracing, and changing of variable values.

The Pro version also enables #define's with macros, and supports standard input-output functions (stdin, stdout, stderr). RUN/C Pro has every feature of RUN/C Lite plus the major infusions cited.

So now RUN/C Professional can tackle projects of any size. Use it as a creative front end to feed a continuous stream of source code into compiled modules — and link to them. Only the source work-in-progress is still interpreted; the finished modules will whiz by at object speeds. It will change how you work. You can bet your living on it.

Version:	Code:	List:	Our Price:
RUN/C Lite	S0910 #	**$120**	**$CALL**
RUN/C Professional	S0950 #	**$250**	

BETTER BASIC

NEW!

BASIC Gets Serious With This Hefty Implementation

If you have several thousand hours of BASIC programming under your wing, what a dilemma the great migration to C poses! Leave all that experience (and code) behind and head for new horizons? Or stay in the nest and become an endangered species?

Along comes BetterBASIC™ Its design principle is simple — build the most useful features of C, Pascal, and Modula 2 into BASIC, while retaining the familiarity of a language already known to millions.

BetterBASIC is big: its hugely expanded features require 192k; your programs can go all the way to the PC's full 640k. It is comfortable; it behaves like Microsoft BASIC at the interactive level, with a full-screen editor, direct statement execution, and always poised to RUN. But it is fast: BetterBASIC is not an interpreter. It is an incremental compiler: each line you type is compiled (and error-checked) when entered, not re-interpreted over and over at run time. So the classic Sieve benchmark runs over *16 times faster* than Microsoft BASIC can manage.

BetterBASIC indents automatically for logical, readable listings, and is sated with statements to encourage structure. Loop structures like FOR, WHILE are treated as sealed-off logical blocks. They safeguard against typical BASIC bedlam by not permitting GOTOs in or out.

BetterBASIC adds the renowned pointers of C. Variables defined as pointers store addresses of other variables of the same type assigned to them, such as arrays or strings. Use pointers to directly load new data into the addresses at much higher speed.

If you know C, you never thought BASIC would ever have structures, but here they are. A structure gathers variables of different types into a record which is given a name. Arrays of such structures may be defined to accommodate data for multiple records. The structure name is all that is needed for file reads and writes, leading to the unmourned demise of FIELD, MKI$, etc., CVD, etc., LSET, RSET. Are you listening Microsoft users? They, and the Babel of redundant variables they needed are, GONE!

BetterBASIC has "procedures". They take the place of BASIC subroutines. Set up in their own work space and edited separately on the screen, procedures cannot run afoul of main program code. They are summoned by name, not (as in GOSUBs) by line number, and variables declared within them cannot be affected by the main program or other procedures unless deliberately passed back and forth.

Best of all, once you have sturdy procedures which can be relied on never to fail, store them in compiled modules. Have BetterBASIC fold in such modules at load time, so they are generally available to your coding, just like PRINT or INPUT. So what have we here? That's right, an extensible language to which you can add your own commands!

There's lots more than fits here. Ask about a runtime module to build COM and EXE files, and a Btrieve interface.

So. . . to C or not to C? Well, maybe not. At last it's a real choice.

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LATTICE C COMPILER

Over 25,000 Users Make it the Best Seller by Far

Lattice C has been the standard-bearer compiler for years. Peter Norton in *PC Magazine* (1/8/85) said, "best for systems programming. . . tight code. . . total control of what's going on. . . noticeably better than any of its competitors". After reviewing nine compilers for the PC, the *PC Tech Journal* unequivocally declared Lattice C "best for software development. . . it compiles fast and produces fast programs."

When Lattice C appeared, there was nothing comparable. Ever since, software developers have created exceptional tools and function libraries to marry into Lattice. Programmers now have an enormous resource of libraries and utilities to speed their work. That's a vital consideration in choosing a compiler. Better check whether the latest geewhiz may have only gewgaws to go with it.

Lattice C runs on virtually any computer using an 8088 or 8086 chip, and generates code which optimizes use of the 8087 chip, if present. Create your source files with any word processor or text editor and Lattice C will compile them into Intel 8086 object module format for linking to other modules by DOS's Link or our Plink86.

Lattice C offers a choice of four memory modules between 64K and RAM capacity for program and data to allow you to choose the right combination of small memory efficiency and large memory addressability. It is a full implementation of Kernighan and Ritchie (K&R), with 39 character variable names, nested comments, transcendental and Unix math functions K&R didn't think to mention, and some of Unix's most useful options such as "fork", to pull a second program into memory alongside the first.

Product Code: S0100 # — List Price: **$500.00** — Our Price: **$265.00**

MARK WILLIAMS C SYSTEM

NEW!

Compile With Built In Source Debugging

With the usual compiler, your source code disappears down a black hole. If your program doesn't do what you intended, there's no telling what's going on in there. Hey, thanks for turning the lights out!

Mark Williams thinks you shouldn't be marooned in space. Their C Programming System™ expands the universe with a source code level debugger which comes with their compiler, so you can watch your own friendly code, not hexadecimal flotsam, float by a window as it executes, with your program's screen output in another window.

You can set tracepoints to stop execution on source lines or when variables change; log functions called to chart the course your program took; change local variables to test different outcomes.

The compiler itself has long been a bright star. It is a full K&R implementation and then some, with enumerated and void data types, structure assignments, and Berkeley rules — fully UNIX compatible. It boasts small and large memory models, 8087 support, ROMable code, DOS calls and the fattest compiler library around. Extensive optimization lets this compiler claim the tightest code and fastest execution of all the compiler luminaries, especially with the large model. User comments confirm it, and so do reviewers: "Has the most professional feel of any package we tested," *Byte* (8/83); "Of all the compilers reviewed,. . . first choice for product development," *PC World* (8/84).

Product Code: S0150 # — List Price: **$495.00** — Our Price: **$425.00**

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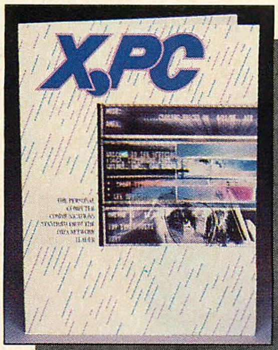

Asynchronous X.25

Tymnet's X.PC protocol establishes error-protected data transmission for asynchronous communications.

Data communications is more than simply sending a byte through a wire—it is ensuring that the byte that exits the wire is the same byte that went in. In the past few years, legions of disjointed methods have arisen to ensure data integrity over a communications line. Large corporate users resort to synchronous modems and leased lines. Small users pass files using simple asynchronous protocols such as XMODEM and, more recently, KERMIT. However, for as much as these incompatible methods have helped, a disturbing portion of data continues to travel over wires and through space with *no* error protection at all. This situation exists mainly because the equipment necessary to connect to the error-detecting X.25 synchronous ports offered by many information utilities is expensive and unlikely to go down in price very soon.

The Tymnet division of McDonnell Douglas offers a bridge to the gap by creating an asynchronous emulation of the International Consultative Committee for Telephone and Telegraph (CCITT) X.25 specification called X.PC. It is not a product but a standard for the development of future products; however, its potential benefit to the industry prompts *PC Tech Journal* to present X.PC as the November Product of the Month.

In developing X.PC, Tymnet needed to address local loop vulnerability between its network and the individual dial-up workstations connected to it. The company, however, has made the specification public enough (including the release of model driver code into the public domain) so that products can incorporate X.PC without using the Tymnet network itself.

X.PC's design parallels closely that of X.25. Both protocols follow the seven-layer International Standards Organization/Open System Interconnection (ISO/OSI) model. The first three layers of X.PC are functionally compatible to the corresponding layers of X.25: the protocol breaks a data stream down into packets that can be routed through any one of 15 logical channels available over a single physical link. X.PC forces an overhead of eight bytes per packet, which is significantly less than competing protocols. Beyond layer 3 X.25 and X.PC diverge slightly in detail, but not in function; the logical connection is monitored and the dialogue between the two communicating nodes is maintained error free.

No file transfer function is defined under X.PC. File transfer is handled by the application, which is layer 7 (the highest layer of the ISO/OSI model). Because layer 7 does not need to deal with error detection at all (the first two layers ensure that no errors go higher in the model), transferring a file is as simple as translating the file into a byte stream and passing the byte stream to the next layer down. The receiving node simply captures the incoming bytes any way it wishes, secure in the understanding that they are correct.

A subtle, but important point to remember is that X.PC is a *binary* protocol that passes eight-bit object code as easily as seven-bit ASCII text. Information utilities using VANs can now make program code, spreadsheet files, and other binary data available to subscribers. And, there is nothing magical about the big-system end of an X.PC connection. Two PCs equipped with an X.PC-capable communications program can realize all of X.PC's benefits over a simple dial-up asynchronous link, even with the simplest of modems.

To set X.PC as a standard, Tymnet has placed its specification document in the public domain, along with sample drivers written in C and 8086 assembly language. (These drivers have been placed in the public domain section of PCTECHline and are available for downloading; they may be distributed freely.) The various documents are available from Tymnet free of charge to responsible parties.

Because X.PC is a much more complicated protocol than XMODEM or KERMIT, vendor support has been slow in coming. Microsoft's Access package supports X.PC, as does the announced but unreleased Crosstalk Mk.4. No public domain or "freeware" packages as yet support X.PC. Effective baud rates attainable with X.PC depend on the bandwidth of the host computer. For a machine like the IBM PC, Tymnet feels that 2400 baud is reliable. The PC/AT and future IBM products probably will double that rate. The limits are implementation-dependent and the last word in drivers has not yet been written.

The time may come when a future generation of PCs supports inexpensive synchronous ports and modems capable of true X.25 communications with most of the intelligence in dedicated silicon. Then big system network architectures such as IBM's SNA will be directly accessible by individual users, and asynchronous communications will be on its way out. With the introduction of X.PC, the wait has been mitigated, and the conversion to X.25, when it comes, may pass all but unnoticed.

PRODUCT NAME
X.PC protocol

COMPANY
Tymnet, a division of McDonnell Douglas

ADDRESS
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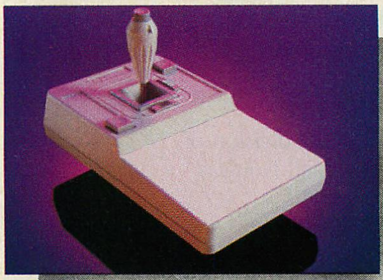
The Personal Silicon Foundry

HARDWARE

Data I/O and **FutureNet** have introduced PC-based workstations that will enable engineers to design, program, and fully test programmable logic devices. A **Personal Silicon Foundry** (PSF) comprises a PC, a set of integrated CAE packages, and a logic device programmer. The CAE package is an integration of FutureNet's DASH-2 schematic capture subsystem and Data I/O's ABEL design language for programmable logic. Data I/O offers a choice of two logic device programmers: the 29B/Logic-Pak, which offers the widest possible device support, and the Model 60A. The elements of the PSF are integrated with DASH-ABEL and PROMlink. Minimum-configuration PSF, $12,950; maximum configuration, $15,140. User-configured systems that include a PC/XT and printer are under $19,000.
Data I/O, 10525 Willows Road NE, P. O. Box 97046, Redmond, WA 98073-9746; 800/426-1045
CIRCLE 313 ON READER SERVICE CARD
FutureNet, 9310 Topanga Canyon Blvd., Chatsworth, CA 91311-5728; 818/700-0691
CIRCLE 314 ON READER SERVICE CARD

The **Model 1018** multi-I/O board provides 96 parallel I/O channels for the PC and bus-compatible microcomputers. Produced by **Industrial Computer Designs, Inc.**, the board includes dual serial ports with jumper-selectable baud rates (110 baud to 19.2Kbaud) and four eight-bit parallel input-only channels. Model 1018 supports full bus interrupts and provides precise communications timing. The board connects to external devices via plug-on connectors with attached ribbon cabling. $495.
Industrial Computer Designs, Inc., 31264 La Baya Drive, Westlake Village, CA 91362; 818/889-3179
CIRCLE 310 ON READER SERVICE CARD

MICROSTICK, engineered for CAD/CAM, CAE, text editing, and graphics applications, is now available from **CH Products**. This point-and-select device offers eight modes of movement, including one that emulates the PC mouse and another that emulates the Bit Pad One from Summagraphics Corporation. It can change from high resolution of 1, 4, or 8 parts in 4,096, depending on the angle of inclination of the stick, to rapid cursor movement at the touch of a button. The MICROSTICK communicates at 300, 1200, 9600, or 19200 baud. $279.95.
CH Products, 1558 Osage Street, San Marcos, CA 92069; 619/744-8546
CIRCLE 319 ON READER SERVICE CARD

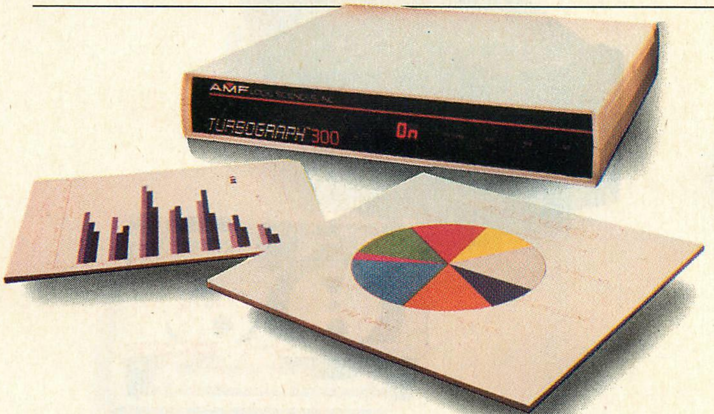


MICROSTICK by CH Products

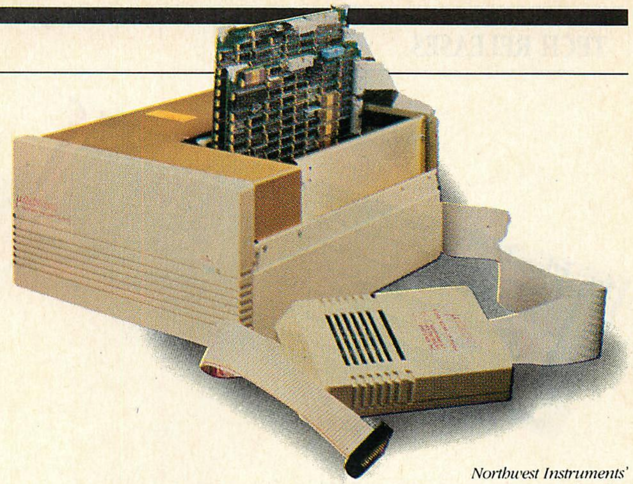
The **Elpho 20**, introduced by **Philips Peripherals, Inc.**, is a nonimpact, electrophotographic page printer that provides letter quality at a speed of 20 pages per minute. Intended as a centralized page printer capable of serving several workstations simultaneously, Elpho 20 handles high-volume information processing. It features quiet operation, a library of more than 95 type fonts, and versatile paper handling. Two configurations are available: the basic printer device, for customization, and a ready-for-installation model that uses an integral print control system. $19,800 each.
Philips Peripherals, Inc., 385 Oyster Point Blvd., Unit 12, San Francisco, CA 94080; 415/952-3000
CIRCLE 311 ON READER SERVICE CARD

ADCoMM 96/48 (advanced communications modem/multiplexer), by **Carterfone Communications Corporation** is a high-speed, full-duplex, asynchronous DDD modem/multiplexer with 100-percent error protection, data compression, and flow control (with a throughput of up to 19.2KB per second). ADCoMM is designed to operate with ASCII CRTs, PCs, minicomputers, and host mainframes to provide a very high speed channel in one direction and a slower speed channel in the opposite direction. Other features include an optional independent statistically mutiplexed printer channel, data compaction, voice grade dial-up operation, half-speed fall-back mode, and Bell 103 compatible mode. $1,995.
Carterfone Communications Corporation, 1341 W. Mockingbird Lane, Suite 1100 W, Dallas, TX 75247; 214/630-9700
CIRCLE 309 ON READER SERVICE CARD

Sublogic Corporation's two-card graphics system, when combined with the systems software provided, gives the PC ultra-high-speed graphics capability. The **High Speed Graphics System** (HSGS) achieves a polygon fill rate of 400 million bits per second and a draw rate of 70,000 line vectors per second. It clips polygons and vectors, and allows programmable windowing with dual display buffers for smooth animation. On-board 256KB display buffer RAM is isolated from the host processor's address space, eliminating slowdown due to host processor limitations and enabling full use of host processor memory. HSGS displays 16 colors simultaneously from a palette of 4,096. Built-in circuitry includes 128 programmable two-color dithering patterns. $2,990.
Sublogic Corportion, 713 Edgebrook Drive, P.O. Box 4019. Champaign, IL 61820; 800/637-4983; in Illinois, 217/359-8482.
CIRCLE 315 ON READER SERVICE CARD



Turbograph 300



Northwest Instruments' SoftAnalyst

A PC-compatible 80286 processor card that improves performance on computational tasks by three to five times has been introduced by **Earth Computers**. Called **TurboAccel-286**, it features 512KB with expansion capability and provisions for an optional 80287 math coprocessor and a switch to run the original 8088. Using the Edsun Labs' EL-286-88 chip, which eliminates the necessity for several other chips, TurboAccel-286 allows the 80286 to emulate 8088 functions, permitting direct execution of the ROM BIOS and DOS. This insures software compatibility and requires no special programming. $995.
Earth Computers, P. O. Box 8067, Fountain Valley, CA 92728; 714/964-5784
CIRCLE 302 ON READER SERVICE CARD

MA Systems has introduced an expansion board for the PC/AT designed to optimize the AT's RAM capability and to maximize the use of its 16MB internal memory potential. The **AT Optimizer** consists of a main board that holds the control logic functions and can be populated with 2.5MB of RAM, and two plug-in option boards. One option board provides an I/O processor while the other can be arranged to provide an additional 2.5MB of RAM. A PC/AT equipped with three AT Optimizer boards supports up to six terminals for high-speed multitasking and multi-use applications. Unpopulated version, $645.

The company also has announced **Magic Removable Winchester**, a half-height, 5¼-inch removable subsystem, available in 5MB and 10MB models; each package includes the removable hard-disk drive, an advanced hard-disk controller, cables, and a power supply. These systems allow for two-way cartridge interchangeability between the PC/XT and the PC/AT. 5MB model, $2,395; 10MB model, $3,495.
MA Systems, 2015 O'Toole Avenue, San Jose, CA 95131; 408/943-0596
CIRCLE 306 ON READER SERVICE CARD

A stand-alone vector-to-graphics processor called **Turbograph 700** for CAD/CAM/CAE systems has been introduced by **AMF Logic Sciences, Inc**. Designed to process monochromatic and color graphics data, it features a VLSI graphics engine that permits high-speed processing and raster-image and input memory expandable to 2MB each. **Turbograph 300** is available for the business graphics market. Turbograph 700, $6,995; Turbograph 300, $1,995.
AMF Logic Sciences, Inc., 10808 Fallstone Road, Houston, TX 77099; 713/879-0536
CIRCLE 307 ON READER SERVICE CARD

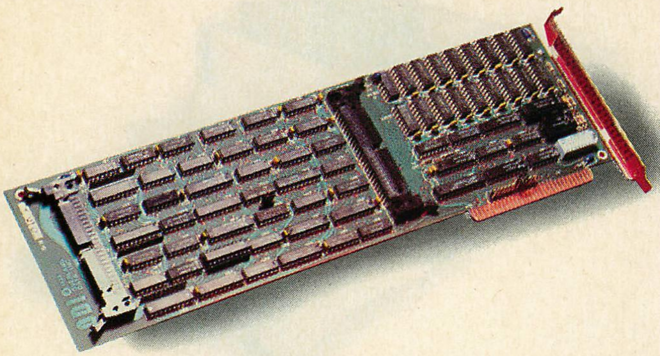
Turbograph 700

The **CM 100 Read-Only Memory Compact Disc Drive** from **Philips Subsystems and Peripherals, Inc.** is a high-capacity data retrieval system. The CM 100 uses 120-mm (4.72-inch), single-sided, ROM compact disks. Data are digitally encoded, then read by a laser beam, decoded, and transferred to either an output device or a computer. Precision optical data recording techniques permit information to be stored with a density many times greater than is possible with conventional magnetic media. These disks offer a storage and retrieval capacity of up to 230,000 text pages. Track-to-track access is possible within one millisecond. Price for OEMs and systems integraters, $1,500.
Philips Subsystems and Peripherals, Inc., 100 E. 42nd Street, New York, NY 10017; 212/850-5125
CIRCLE 312 ON READER SERVICE CARD

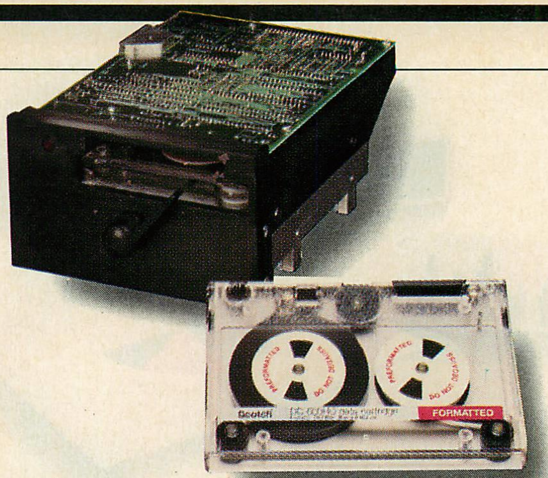
The first integrated tool set for microprocessor software analysis, **SoftAnalyst**, has been introduced by **Northwest Instrument Systems, Inc**. Supporting a variety of microprocessors, compilers (including Pascal, C, FORTRAN, and ADA), and cross assemblers, it analyzes performance, trace procedures, and variables and test code coverage in realtime nonintrusively. The SoftAnalyst package includes chassis, boards, microprocessor-specific probes, and software. Prices start at $9,955.
Northwest Instrument Systems, Inc., 19545 N. W. Von Neuman Drive, Building D-4, Beaverton, OR 97006; 503/690-1300
CIRCLE 303 ON READER SERVICE CARD

Digital Communications Associates, Inc. (DCA) has introduced **Smart Alec**, a micro-to-IBM System/34, /36, or /38 communications link. Smart Alec allows the PC, PC/XT, and PC/AT to emulate an IBM 5251 Model 11, 5291, or 5292 Model 1 terminal. It provides for direct attachment to a S/34, /36, or /38, or remote attachment, through modem, to an IBM 5294 workstation controller or an IBM 5251 Model 12. Smart Alec includes bidirectional file transfer software, while allowing the PC to maintain its stand-alone processing capabilities. Also available is the **Enhanced File Transfer** software, which features increased data security, record blocking, file chaining, and record selection. Smart Alec, $995; File Transfer software per host, $1,295.

DCA's **FASTLINK** is a modem that lets PC users send information to other PCs and host computers at speeds of up to 10,000 bits per second. FASTLINK permits the transmission of enhanced graphics and increased access to information data banks. Card version $1,995; stand-alone $2,395.
Digital Communication Associates, Inc., 1000 Alderman Drive, Alpharetta, GA 30201; 404/442-4000
CIRCLE 301 ON READER SERVICE CARD

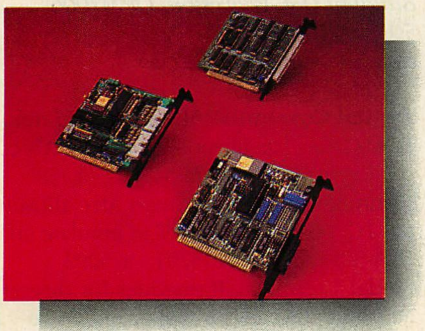


Overland Data's TC-50



HCD-134 by 3M

Half-size I/O cards for the PC have been introduced by **Data Translation**. Supporting analog inputs, analog outputs, and digital I/O, respectively, the **DT2814, DT2815**, and **DT2817** plug into any I/O expansion slot on the PC, PC/XT, and PC/AT. Potential applications for the cards include data logging, process control, energy management, chromatography, signal analysis, and laboratory automation. DT2814, $299; DT2815, $399; DT2817, $199.
Data Translation, 100 Locke Drive, Marlboro, MA 01752; 617/481-3700
CIRCLE 316 ON READER SERVICE CARD



Data Translation's half-size cards

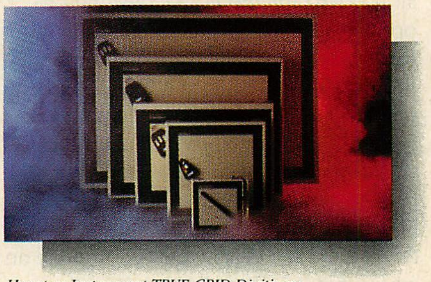
KA Design Group offers an alternative to the mouse and the tablet. Its **TurboPuck** is a point-and-select device that featuress high resolution and fast positioning. The device has extensive onboard intelligence to communicate on the RS-232 serial standard; it may be commanded to emulate a mouse or tablet, or exercise three-axis control, cursor control, or instrumentation and industrial control. TurboPuck automatically tracks in straight horizontal lines, switches from two-dimensional to three-dimensional operation, and features an optical switch to select from the different operating modes. $159.95.
KA Design Group, 6300 Telegraph Avenue, Oakland, CA 94609; 415/654-6300
CIRCLE 317 ON READER SERVICE CARD

Series 9000 is a transportable one-half-inch tape system for the PC, PC/XT, and PC/AT that provides a data interchange link to mini- and mainframe computers and tape libraries. Introduced by **Cipher Data Products, Inc.**, it allows PCs to upload and download mainframe data without data communication costs or a need for micro-to-mainframe networking. It also can be used as a data backup and archival storage device. Prices range from $5,995 to $10,995.
Cipher Data Products, Inc., 10101 Old Grove Road, P. O. Box 85170, San Diego, CA 92138; 619/578-9100
CIRCLE 308 ON READER SERVICE CARD

From **Overland Data, Inc.** comes **TC-50**, a high-performance nine-track tape controller for the PC, PC/XT, PC/AT, and compatibles. TC-50 offers 8-bit parallel recording with parity, switch-selectable I/O address, a maximum data transfer rate of 400,000 bytes per second, a record length of 1 to 65,535 bytes, support for as many as eight tape transports, and a jumper-selectable DMA channel. The package includes controller board, interconnect cables, and a variety of software utilities. $1,350.
Overland Data, Inc., 5644 Kearny Mesa Road, Number A, San Diego, CA 92111; 619/571-5555
CIRCLE 320 ON READER SERVICE CARD

3M has announced a new one-fourth-inch cartridge drive in a 5¼-inch form factor that greatly increases user capacity. The **HCD-134** data cartridge drive system provides 134MB of fully-corrected user data per formatted one-fourth-inch data cartridge. The HCD-134 has an average access time of 14 seconds using random track access and bidirectional search, and provides data transfer at greater than 4MB per minute. Less than $1,000 in OEM quantities.
3M, P. O. Box 33600, St. Paul, MN 55133-3600; 612/736-2355
CIRCLE 304 ON READER SERVICE CARD

Houston Instrument has announced seven new digitizers. Called TRUE GRID, the products are designed for cursor control and menu-picking applications. They offer users a complete line of graphics input tablets. Digitizers in the **1000 series** feature medium resolution of .005 per inch, accuracy of +/− .015 per inch, a choice of transducers, and three sizes of active area. The **8000 series** digitizers are designed for mechanical, electrical, surveying, mapping, and architectural applications. They feature high resolution of .001 per inch, accuracy of +/− .01 per inch, optional choice of transducers, and four sizes of active area. 1000 series, $495 to $975; 8000 series, $1,150 to $4,340.
Houston Instrument, 8500 Cameron Road, Austin, TX 78753; 512/-835-0900
CIRCLE 321 ON READER SERVICE CARD



Houston Instrument TRUE GRID Digitizers

Universal Data Systems, Inc. (UDS) has introduced a line of Hayes-compatible modems. The **FasTalk** series boasts full call-progress monitoring of dial tone, busy, ring, and connect signals. The modems feature automatic dialing, selection of pulse or tone dialing, and answering with automatic speed selection. UDS includes its **SignOn** software package with each FasTalk. FasTalk 300 desktop modem, $345; 1200 desktop or 1200 PC plug-in card modem, $525.
Universal Data Systems, Inc., 5000 Bradford Drive, Huntsville, AL 35805-1953; 205/837-8100
CIRCLE 318 ON READER SERVICE CARD

New Version

Sizzling C.

The fastest C. The C that Microsoft developed to write its own software programs. Hot.

So hot that we can make this claim: Virtually every program runs faster with Microsoft® C Compiler than with any other MS-DOS® C compiler.

Efficient C.

We give you everything you need to write code so tight your computer will scream.

"Preliminary testing on the Microsoft C Compiler produced code that was significantly smaller than that produced by other C compilers."
Paul Springer, Ashton-Tate.

"We found the FAR pointer very helpful for situations where a mix of memory models offers the greatest efficiency."
Robert Frankston, Software Arts.

"The portability of the code between MS-DOS and XENIX® is great."
Jim Bean, Peachtree Software.

But it's really no surprise that our C stretches your micro to its limits. We wrote both the MS-DOS and the XENIX operating systems.

For the name of your nearest Microsoft dealer, or to upgrade from Microsoft C Compiler or Lattice C, call (800) 426-9400. In Washington State, Alaska, Hawaii and Canada, call (206) 828-8088.

And make your programs really cook.

MICROSOFT®
The High Performance Software™

Microsoft C Compiler Version 3.0

Microsoft C Compiler
- Produces compact code and fast executables.
- Implements register variables.
- Small, Medium and Large Memory model Libraries-Mix models with NEAR and FAR pointers.
- Transport source and object code between MS-DOS & XENIX operating systems.
- Library routines implement most of UNIX System V C library.
- Choose from three Math libraries and generate in-line 8087/287 instructions or floating point calls.
  - Floating point emulator (utilizes the 8087/287 if installed).
  - 8087/287 coprocessor support.
  - Alternate math package—extra speed on systems without an 8087/287.
- Link routines written in Microsoft FORTRAN (V 3.3 or higher), Microsoft Pascal (V 3.3 or higher) or Microsoft Macro Assembler.
- Supports MS-DOS pathnames and Input/Output redirection.
- File sharing and record and file locking is supported.
- Do source level debugging, with the Symbolic Debug Utility, available separately with the Microsoft Macro Assembler Package.*

Library Manager
Create, organize and maintain your object module libraries created with Microsoft languages.

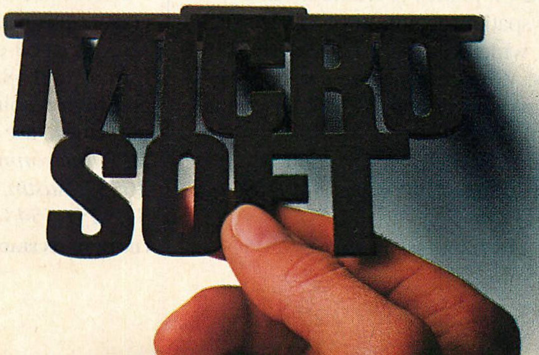
Object Code Linker
- Simple overlay linker combines relocatable object modules created using Microsoft Languages into a single program.
- Link very large programs (over 1MB, using overlays).

EXEPACK Utility
A new utility to compress sequences of identical characters from an executable file and to optimize the relocation table.

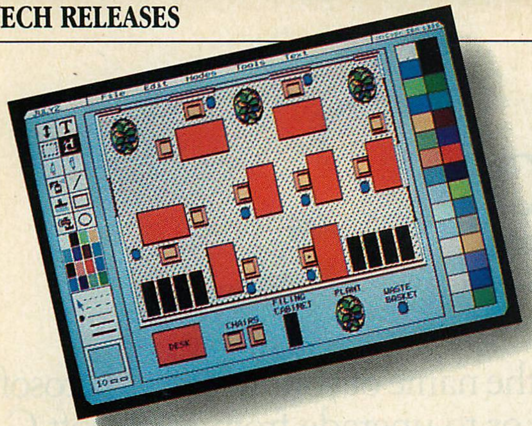
EXEMOD Utility
A new utility used to modify the fields in the header according to the instructions given by the user in the command line.

'C' Benchmarks—done on a Compaq Plus with 512k memory with no 8087. Program "SIEVE," with register variables,

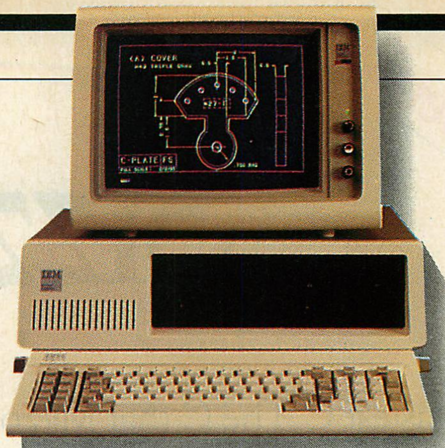
	Exec Time	Code Size	EXE Size
Microsoft C	:9.39	141	5,914
Lattice C	:12.24	164	20,072



*Purchase both Microsoft C Compiler and Microsoft Macro Assembler and get a $25 rebate direct from Microsoft. See package for details.



Floor plan screen by IBM's Drawing Assistant



Tempo from PMX

Gateway Communications, Inc. has developed a high-performance coprocessor option board called **PC-WNIM** for the communications requirements of the PC and compatibles. PC-WNIM (wide area network interface module) acts as a bridge in support of communications software and applications such as X.25, SNA, and Async. Properly prepared, PC-WNIM can provide LAN-to-LAN, LAN-to-host, and LAN-to-remote device connections. It has a Z80-B CPU (6 mHz) clocked at the PC rate multiple of 4.77 mHz; 64KB of dual-ported, parity-checked RAM; and serial communications support logic for four RS-232 or RS442 communications ports. The I/O and memory addresses can be configured with an 8-position dip switch to resolve conflict with other installed option boards on the PC. PC-WNIM supports both asynchronous and synchronous communications. $595.
Gateway Communications, Inc., 16782 Redhill Avenue, Irvine, CA 92714; 714/261-0762
CIRCLE 305 ON READER SERVICE CARD

The **FG-100-AT** by **Imaging Technology** provides realtime image processing capabilities. It is a single-board subsystem capable of digitizing analog video from standard RS-170 video sources, processing the imagery into realtime, and displaying the stored image in monochrome or pseudocolor. The board's functionality is made possible by advanced architecture and the extensive use of gate arrays and surface-mounted devices. The FG-100-AT contains 12 bit planes of frame memory, with a spatial resolution of 512-by-512 pixels, which can be used in several modes. Monochrome version, $3,995; pseudocolor version, $4,495. Discounts available for OEMs.
Imaging Technology, Inc., 600 W. Cummings Park, Woburn, MA 01801; 617/938-8444
CIRCLE 322 ON READER SERVICE CARD

SOFTWARE

A new member to **IBM**'s PC Assistant Series, the **Drawing Assistant**, is a creative design tool for drawings, floor plans, charts, diagrams, and other graphic presentations. Program highlights include: an art library containing symbols, maps, patterns, and drawings; a zoom feature that permits magnification and retouching; pattern creation; brush style selection and the ability to paint with 2 to 16 colors at one time; and selective removal of portions of a freshly painted drawing. $169.
IBM, Entry Systems Division, P. O. Box 1328, Boca Raton, FL 33432; Contact the local IBM dealer
CIRCLE 323 ON READER SERVICE CARD

To achieve full compatibility with all software written for the IBM PC Network Adapter, **AST Research, Inc.** has introduced the **AST-NETBIOS Option** for its series of LANs. The basic package includes utility software and a software driver that configures to the user's specific hardware. $195 per network.
AST Research, Inc., 2121 Alton Avenue, Irvine, CA 92714; 714/863-1333
CIRCLE 329 ON READER SERVICE CARD

I/O PRO is a development tool for the creation of text and graphic screens used as the I/O media for interactive programs. Developed by **MEF Environmental, Inc.**, I/O PRO includes a screen development and testing module, plus a library module with a FORTRAN/Pascal screen caller, a screen conversion routine that allows existing screens to be converted to I/O PRO format, and 58 utility routines. Color and high-resolution graphics, including animation, are supported. $450.
MEF Environmental, Inc., P. O. Box 26537, Austin, TX 78755; 512/251-5543
CIRCLE 327 ON READER SERVICE CARD

PMX, Inc. has introduced an easy-to-use graphics tape editor for the PC. **Tempo** accepts programming in a single generic format and then converts the code as necessary to operate nearly any machine tool. A CAD-type function allows geometric data to be entered and graphically displayed either as the program is being produced or after completion, and includes automatic calculation of tangencies and intersections. Tempo also features dimensioning and text, zooming, rotation, and scaling capabilities. $1,995.
PMX Inc., 33129 Schoolcraft, Livonia, MI 48150; 313/422-3740
CIRCLE 331 ON READER SERVICE CARD

The **Remote File Manager** (RFM), which allows file transfer between networked PCs and a DEC VAX, is available from **Syntax**. The product permits the PC user to manipulate VAX files directly wherever they reside in the DECnet domain. A user can rename a file on his PC to a file that is to reside on a remote DECnet VAX. RFM automatically establishes the file on the remote VAX and erases the local PC file. This product is an addition to the Syntax VAX Interface Manager (VIM) networking software series; users must have VIM to use RFM. VIM, $7,500; RFM, $2,500.
Syntax, 6642 S. 193rd Place, Suite N-107, Kent, WA 98032; 206/251-8438
CIRCLE 332 ON READER SERVICE CARD

Laboratory Technologies Corporation has announced a contractual agreement under which **IBM Corporation** will distribute LABTECH NOTEBOOK. An integrated, menu-driven, general purpose software package for data acquisition, process control, monitoring and analysis, it runs on the PC, PC/XT, PC/AT and compatibles. $895.
Laboratory Technologies Corporation, 255 Ballardvale Street, Wilmington, MA 01887; 617/657-5400
CIRCLE 324 ON READER SERVICE CARD

New Version

Mighty Macro Assembler.

The new Microsoft® Macro Assembler package. A complete development environment that makes you a more productive programmer. Whether you're using Macro Assembler or any Microsoft high level language.

A common calling convention lets you easily call assembly language routines from any high level Microsoft language to add an extra burst of blinding speed.

Better Debugging.

The new Symbolic Debug Utility lets you stay close to the source. Now you can step through your assembled or compiled code by name rather than by address. Source level display for Microsoft Pascal, FORTRAN, and C allows you to view both your original source and the resulting code.

And we stuffed our package with a full set of the most useful utilities around. So that you can link, maintain and organize your programs like never before.

Who else but Microsoft could build so much into one package for $150?

For the name of your nearest Microsoft dealer call (800) 426-9400. In Washington State, Alaska, Hawaii and Canada, call (206) 828-8088. And if you're already using Microsoft or IBM® Macro Assembler, ask us how you can upgrade to the mightiest Macro of them all.

MICROSOFT.
The High Performance Software™

Microsoft Macro Assembler Package:

Macro Assembler
- For the 8086/8087/8088 and now the 186/286/287.
- Define macros.
- Conditional Assembly.
- Case sensitivity for symbols.

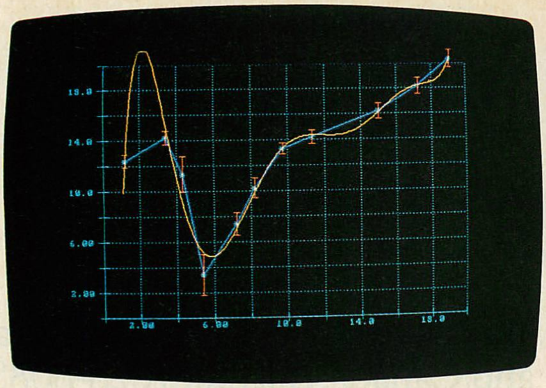
New Interactive Symbolic Debug Utility
- Controlled testing environment for debugging.
- Source line display of Microsoft FORTRAN, Pascal and C Programs.
- Set breakpoints on line numbers and symbols.
- Single step to follow program execution.
- Disassemble object code.
- Display values.
- Make minor changes without reassembling.

New Program Maintenance Utility
- Rebuilds your applications after your source files have been changed.
- Similar to UNIX™ Make utility.

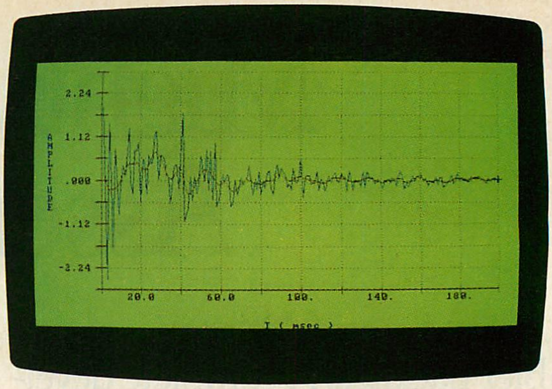
Library Manager
- Create, organize and maintain your object module libraries created with Microsoft Languages.
- Set page size (default of 16 bytes).

Object Code Linker
- Simple overlaying linker combines relocatable object modules created using Microsoft Languages into a single program.
- Load Map generation.
- Specify from 1 to 1024 segments.

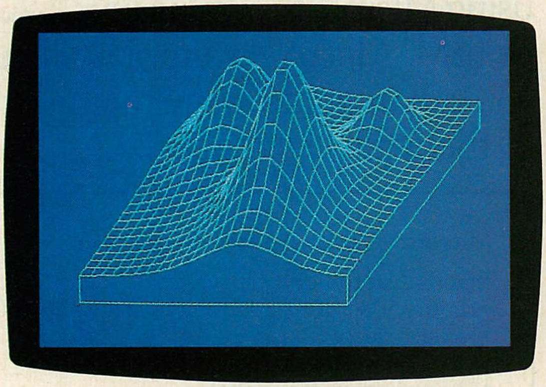
Cross Reference Utility for the Macro Assembler
- Creates a cross-reference listing of the definitions and locations of all symbols used in an assembly language program.



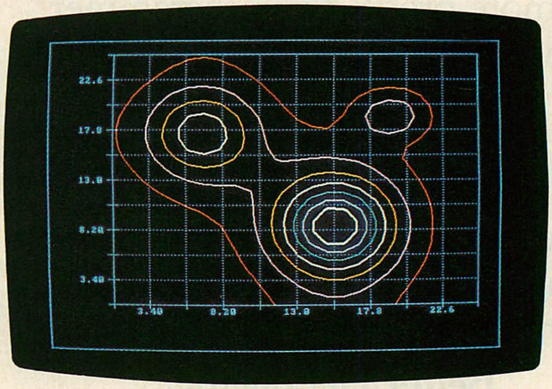
ASYST high-resolution graphics now include error bars, labels, axes, grids, and multiple colors.



New color graphics enhance comparison of experimental data with filtered data.



ASYST axonometric plots simplify analysis of complicated 3-dimensional surfaces.



Contour plotting adds an alternative approach to meaningful 3-D representation.

ASYST™ adds new muscle.

More hardware support, more analysis capabilities for the IBM PC.

ASYST™ Scientific Software turns your IBM PC, XT,™ AT, or compatible into a complete scientific workstation. And now it's even more versatile, with:

- Expanded analysis capabilities
- High-resolution color graphics
- GPIB/IEEE-488 hardware support
- Axonometric and contour plotting
- Additional A/D hardware support

Minicomputer speed and precision—at a fraction of the cost.

ASYST on an IBM PC does a 1024-pt. FFT in less than 3 seconds (as fast as 1.2 on some compatibles). For the same task, an optimum performance routine on a DEC 11/23+ minicomputer using FPF 11™ took 2 seconds—at 5 times the price!

Built-in routines. Full programmability.

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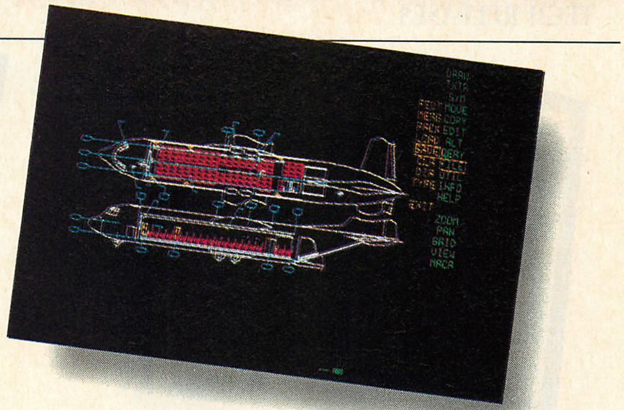
Quick BASIC by Microsoft



CADVANCE screen

An integrated systems engineering environment that uses proven methodologies for faster design time, reduced maintenance, and generation of reusable code has been introduced by **Promod, Inc.** The **ProMod** environment supports the complete software life cycle on PCs and minicomputer systems; currently versions are offered for all DEC VAX systems, as well as the PC, PC/XT, and PC/AT. Analysis data can be exchanged between VAX and IBM systems at any time during the cycle. ProMod's five major sections are requirements analysis and definition, transformation from analysis to design, system design, program design, and implementation. Pricing is based on system configuration; it begins at $9,950 for PC.
Promod. Inc., 22981 Alcalde Drive, Laguna Hills, CA 92653; 714/855-3046
CIRCLE 330 ON READER SERVICE CARD

Concord Data Systems has introduced LAN software that significantly reduces the cost of connecting manufacturing automation protocol (MAP)-compatible devices and terminals. **Token/Net** uses Concord's four-port interface module to provide MAP-compatible and terminal interfaces to the 802.4 token bus LAN. The software also provides synchronous and asynchronous terminal support over three RS-232 serial ports. $5,135.
Concord Data Systems, Inc., 303 Bear Hill Road, Waltham, MA 02154; 617/890-1394
CIRCLE 333 ON READER SERVICE CARD

Microsoft, Lotus, and Intel have announced that Microsoft will participate in support and control of the expanded memory specification which takes the memory of the PC, PC/XT, and PC/AT up to 8MB above the 640KB limit. The effort originally was unveiled by Lotus and Intel in April 1985 and will now be called the **Lotus/Intel/Microsoft expanded memory specification** (the release of version 3.2 with support for multitasking was coincident with this announcement). Microsoft will integrate expanded memory capabilities into future systems software products.

Separately, Microsoft has released **QuickBASIC**, a BASIC compiler that offers execution speeds three to ten times faster than the BASIC interpreter. New structured programming features include subprograms, libraries, alphanumeric labels, multiline functions, and control structures. QuickBASIC supports large programs, advanced graphics capabilities, and networking. $99.
Microsoft Corporation, 10700 Northup Way, P.O. Box 97200, Bellevue, WA 98009; 800/426-9400
CIRCLE 325 ON READER SERVICE CARD

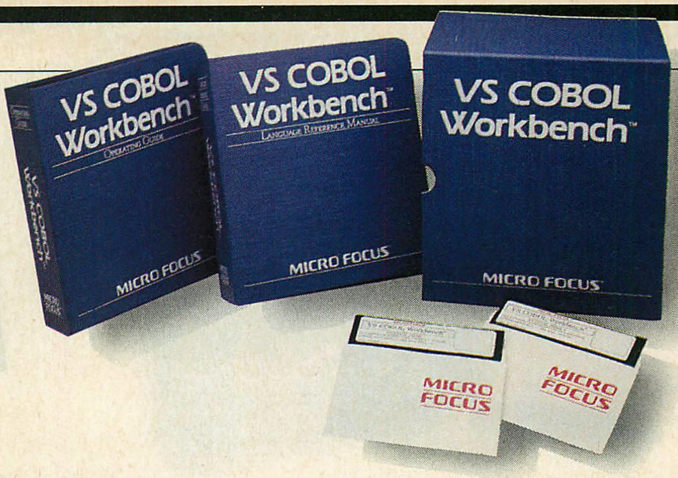
CalComp has announced the acquisition of the architectural, engineering, construction (AEC) division of Personal CAD Systems (P-CAD). The renamed **personal systems unit** markets three software packages: CADPLAN, used to create, edit, and plot designs for AEC applications; CADDRAFT, an entry-level drawing and drafting package; and CADMATE, a user-friendly, self-paced tutorial for learning CADPLAN. A fourth, CADVANCE, will provide design capabilities through the use of variable interpretive macros, previously available only on high-end CAD systems. CADPLAN $2,000; CADDRAFT, $495; CADMATE, $100; CADVANCE, $2,500.
CalComp, 200 Hacienda Avenue, Campbell, CA 95008; 408/866-6272
CIRCLE 336 ON READER SERVICE CARD

HTEST/HFORMAT is a disk-help utility from **Kolod Research, Inc.** HTEST performs nondestructive tests against a given hard disk. Three different tests are available in addition to the user-supplied parameters, such as start track, end track, and disk parameter override. HFORMAT is used if HTEST reveals a problem or if the media is known to be defective. It will format and test each disk track a minimum of 32 times, during which process a set of bit patterns designed to exercise the media in all possible combinations will be written onto the disk. The results of the tests and the formatting process are continually displayed; on-line help facilities are provided. $129.95.
Kolod Research, Inc., P.O. Box 68, Glenview, IL 60025; 312/291-1586
CIRCLE 339 ON READER SERVICE CARD

Emerald Technology Group, Inc., in conjunction with **Software Systems, Inc.**, has announced a new version of SSI's **Emulator Transfer Utility** (ETU). Release 2 provides support for the IBM 5250 emulation kit and the IDEAcom 5251; transfer of print spool files from the System/3x for off-line printing on the PC or from the PC to a high-speed system printer on the S/3x; the ability to copy library members between the PC and the S/3x; mapping of PC formats and ASCII fixed, variable, and text to EBCDIC format or vice versa; and performance improvement. S/34, $400; S/36, $500; S/38, $800.
Emerald Technology Group, Inc., 1601 116th Avenue NE, Suite 102, Bellevue, WA 98004; 206/462-8200
CIRCLE 342 ON READER SERVICE CARD

Previously available only for mainframes, **MODEL** software by **Lloyd Bush Software Products** is now ported to the PC/AT by running in protected virtual address mode. MODEL is a workspace-oriented fourth generation language for professional analysis of complex business situations. It supports simple direct interfaces to a wide variety of database management and graphics systems. In its implementation on the 80286, it can support applications of up to 16MB. $3,000 to $5,000 depending on specific configuration.
Lloyd Bush Software Products, 156 William Street, New York, NY 10038; 212/962-4004
CIRCLE 338 ON READER SERVICE CARD

Gracon Services' TurboRef



VS COBOL by Micro Focus

Gracon Services, Inc. has announced **TurboRef**, a software tool package for Pascal users. TurboRef will cross-reference a Pascal program and create a program listing; it lists each variable and constant reference, including the line number and type of use for each reference. This utility reads multiple Pascal source files and can process Pascal include files. $49.95.
Gracon Services, Inc., 4632 Okemos Road, Okemos, MI 48864; 517/349-4900
CIRCLE 340 ON READER SERVICE CARD

A screen and form generator called **ZIP** that writes program code for dBASE II and dBASE III has been announced by **Magnum Data, Inc**. With ZIP, the user paints the application input or output screen or print format that he needs on his CRT. Using the built-in ZIP editor, he types in prompts, lines, boxes, fields, variables, and dBASE functions. He then saves the screen and ZIP writes a dBASE program that will reproduce the format; this program can be merged or called using a DO statement. $50.
Magnum Data, Inc., 627 S. Plymouth Blvd., Los Angeles, CA 90005; 213/937-0848
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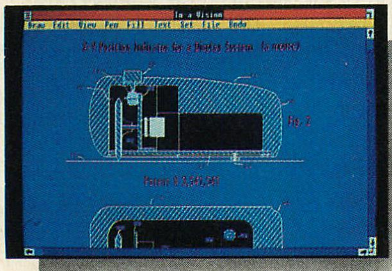
TEXTBANK/PC, from **Group L Corporation**, manages textual information on the PC/XT or PC/AT. It allows a user to build and search his own information base which, unlike a database, can accommodate unstructured data. The user can search using any word, part of a word, word combination, or word proximity. He can target search and display areas by using zones, which are more flexible than database fields. Zones are natural text groupings, such as sentences, paragraphs, or tables. $995.
Group L Corporation, 481 Carlisle Drive, Herndon, VA 22070; 703/471-0030
CIRCLE 341 ON READER SERVICE CARD

MICROGRAFX, **Inc.** has announced **In*a*Vision**, the first Microsoft Windows-compatible applications package. This computer-aided design and drawing software employs a mouse interface and can be used stand-alone or in conjunction with Windows. In*a*Vision offers sophisticated multiple-font text capabilities; users choose drawing and editing functions from pull-down menus. In addition to zoom capabilities, this product is able to stretch, rotate, scale and dimension figures. Accuracy is ensured with rulers, crosshairs, dimensioning features, and flexible grids. $495; demonstration system, $49.
MICROGRAFX, Inc., 1820 N. Greenville Avenue, Richardson, TX 75081; 214/234-1769
CIRCLE 328 ON READER SERVICE CARD



In*a*Vision screen

Image-processing technology is adapted to the microcomputer environment with **Media Cybernetics'** latest product, **Image-Pro**. This interactive, icon-driven software enables information from documents, photographs, x-rays, and satellites to be electronically captured, processed, analyzed, stored, and retrieved. The package consists of a stand-alone mouse-driven image processing package with an icon-based image editor, image processing routines, and the HALO graphics subroutine library. $1,000.
Media Cybernetics, Inc., 7050 Carroll Avenue, Takoma Park, MD 20912; 301/270-0240
CIRCLE 334 ON READER SERVICE CARD

VS COBOL is a new high-speed compiler from **Micro Focus** that generates 8086 native code and supports the full ANSI 12-module. Its increased functionality includes PC screen and keyboard support, an internal sort/merge, extended communications, and support for Report Writer. $1,200.

Also from Micro Focus comes CO-MATH, a COBOL-expanding library of mathematical functions that includes exponentiation, power, square root, natural log, log 10, sine, cosine, tangent, arcsine, arccosine, arctangent, and arctangent XY. CO-MATH is designed for use in a standard COBOL environment. $200.
Micro Focus, 2465 E. Bayshore Road, Palo Alto. CA 94303: 415/856-4161
CIRCLE 326 ON READER SERVICE CARD

Technisoft is positioning its **File Savior** disk utility as an EBCDIC sector editor; it can display, search, and modify files that are in EBCDIC format. This is the format in which most mainframe files downloaded to PCs often remain. File Savior also handles ASCII and hexidecimal data, and enables the user to recover erased files and salvage data from damaged disks. File Savior runs on the PC, PC/XT, and PC/AT. $49.95.
Technisoft, 1710 Allied Street, Suite 37, Charlottesville, VA 22901; 804/979-6464
CIRCLE 335 ON READER SERVICE CARD

Three new versions of the NOVA*GKS computer graphics software, based on the international graphical kernel system and produced by **Nova Graphics International**, have been announced by that company. The new products bring GKS to the PC/XT, PC/AT, and the 3270 AT/G and AT/GX workstations in both FORTRAN and C. PC version, $495; 3270-based versions, $1,500.
Nova Graphics International Corporation, 1015 Bee Cave Woods, Austin, TX 78746; 512/327-9300
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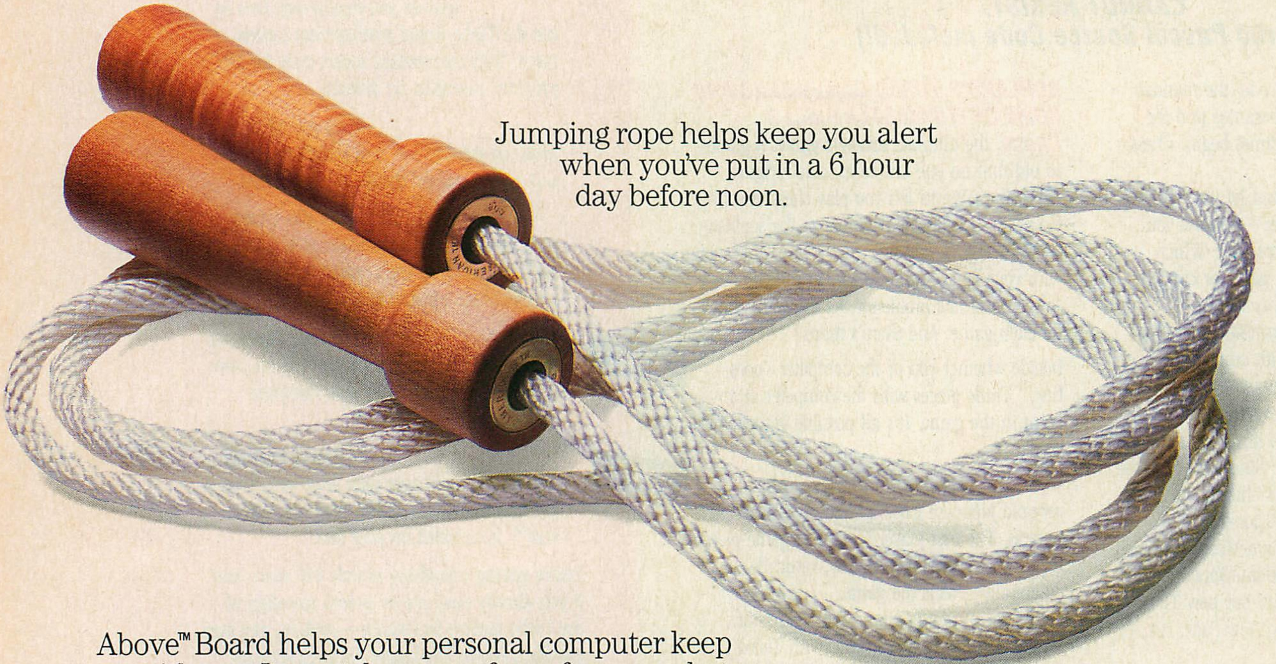

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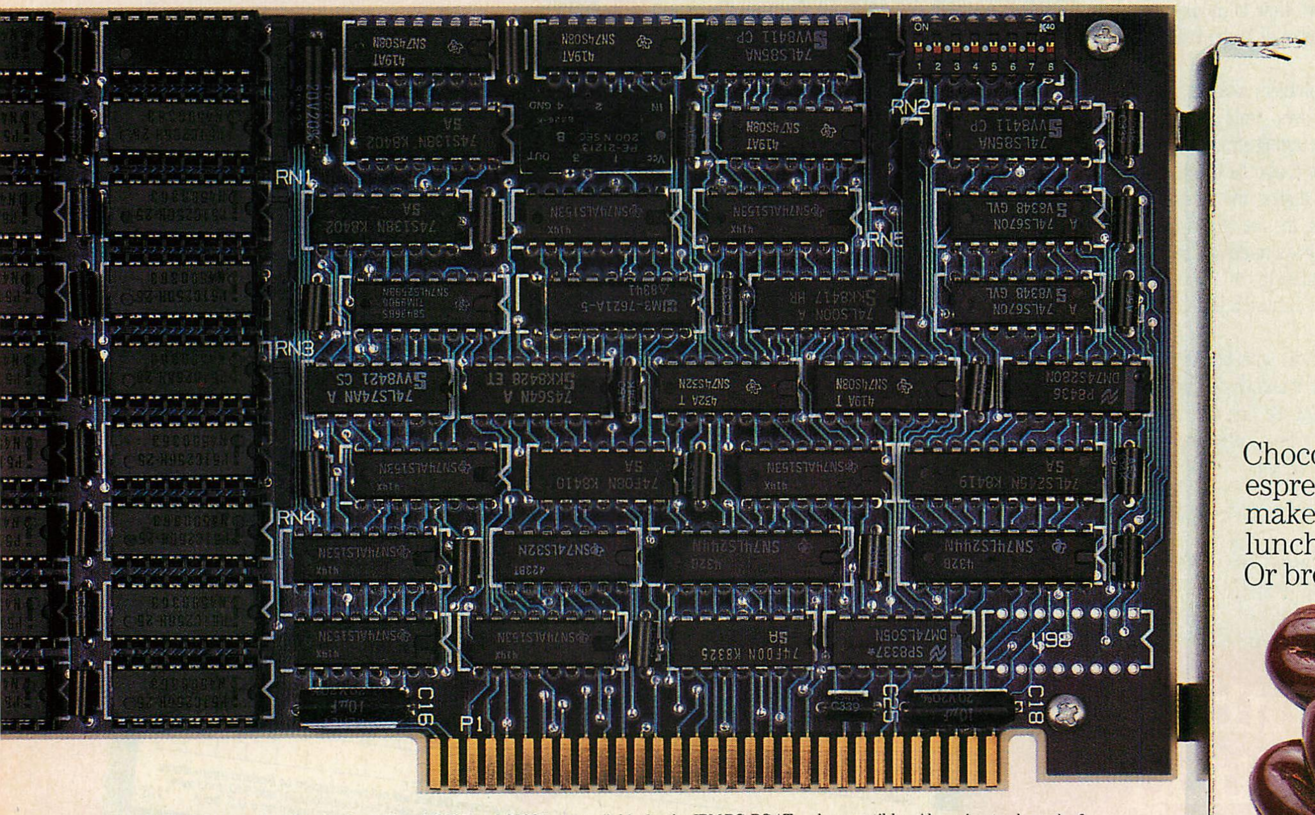

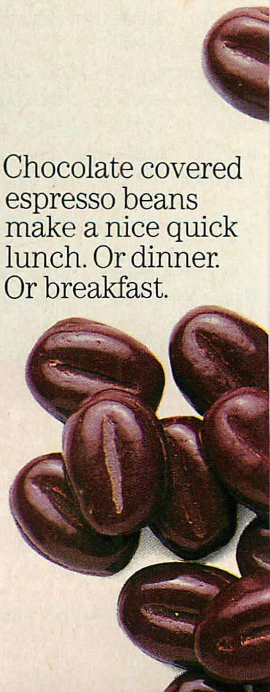

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Self-Installing Software

The key is an assembly language routine that reports system configuration.

Most of today's software packages must be installed on a particular hardware configuration before they will perform at their best. But what about the user who needs to run one package on a number of different systems? The installation could be performed again and again for each use; this, however, soon would become a bother, and forgetting the process might require a cold restart.

The ability to install software on a variety of systems can be automated by means of a batch file, if the batch procedure is able to branch conditionally according to the configuration of each new system. The most useful method of branching in batch files uses the IF ERRORLEVEL statement, where the value of ERRORLEVEL is returned by a program that determines the hardware configuration of the system. The example given here shows the automatic installation of Lotus 1-2-3 on either a monochrome or a color/graphics system, but the principle is readily extendable to other programs with installations that depend on any hardware characteristic detectable by an assembly language program.

The installation of Lotus 1-2-3 involves the copying of both text and graphics driver files. Normally, the user must specify whether a monochrome or a color/graphics display is being installed so that those drivers appropriate to the specified display may be copied. The procedure presented here determines this automatically, then performs the required installation of drivers based on the video mode of the system. The key is the assembly language program VIDMOD, which determines the video mode (monochrome or graphics) and returns it as the value of ERRORLEVEL. A batch file can then branch on this value and copy the driver files.

Because VIDMOD is such a simple program, it is most easily created with the assembly feature of DOS DEBUG. Type in the boldface text shown in the figure. The program locates the video mode in location 40:49 of the BIOS data area and returns the value of this mode to the calling process (in this case, the DOS batch file) by placing the value in register AL and exiting with INT 21H, function 4CH. The ERRORLEVEL statement then tests the value of this return code.

The presence of a graphics driver is used to determine whether a monochrome or a color/graphics display is installed. If a monochrome card is active, VIDMOD returns a value of seven into ERRORLEVEL; if a color/graphics adapter is active, a value less than seven is returned. The batch file LOTUS.BAT uses this value of the video mode returned by VIDMOD to determine its branch between one of two installation sequences. The installation procedure is skipped if the current configuration is the same as the new one. A review of the listings MONO.BAT and COLOR.BAT, both on the Lotus utilities disk, will clarify this installation procedure.

To use this method with release 1A, rename file LOTUS.COM to LOTUSX.COM on the 1-2-3 system disk, and copy VIDMOD.COM, LOTUS.BAT, IBM0MONO.DRV, IBM1G2.DRV, AND IBM0COLO.DRV from the utility disk to the system disk. Copy IBM0MONO.DRV to TD.DRV before executing LOTUS.BAT for the first time.

This scheme may be extended for use with any two-way or multiway branch on any hardware characteristic: memory size, the presence of both monochrome and color/graphics adapters simultaneously, the number of printers or serial ports, an 8087 processor, or the type of computer. (See "Machine Specifics," Ted Forgeron, June 1985, p. 181.)

Ted Mirecki has a master's degree in computer science and 20 years of experience in information processing.

FIGURE: *VIDMOD*

```
debug vidmod.com
File not found                  ;ignore this message
-A 100
xxxx:0100 MOV AX,40
xxxx:0103 MOV DS,AX             ;set DS to ROM data segment
xxxx:0105 MOV AL,[49]           ;get video mode into AL
xxxx:0108 MOV AH,4C             ;exit w/return code in AL
xxxx:010A INT 21
xxxx:010C                       ;just return on this line
-R CX                           ;set length of file
:C
-W                              ;write it to disk
Writing C bytes
-Q                              ;leave debug
```

LISTING: LOTUS.BAT

```
echo off
vidmod
if errorlevel 7 goto mono
:color
if exist gd.drv goto done
echo Loading color/graphics drivers
copy ibm0colo.drv td.drv
rename ibm1g2.drv gd.drv
goto done
:mono
if exist ibm1g2.drv goto done
echo Loading mono drivers
copy ibm0mono.drv td.drv
rename gd.drv ibm1g2.drv
:done
echo on
lotusx
```

PAUL F. HULTQUIST

Doubly Careful

Accurate double-precision calculations in IBM BASICA require specific procedures.

BASICA's double precision must be handled carefully or it will return only single-precision results. Versions 2.0 and later of IBM BASIC contain a cryptic note in the manual indicating that if the user types BASIC /D or BASICA /D, he will be blessed with double-precision versions of SIN, COS, TAN, ATN, EXP, LOG, and SQR. But beware—a comparison of BASIC's double-precision results and tabulated values can be disappointing. In one test case, the double-precision functions evidenced only single-precision accuracy.

Further investigation revealed the problem: the double-precision BASIC functions are accurate, but it is necessary for the user to know exactly how BASIC handles double precision in order to use the functions correctly.

First, double-precision functions must receive double-precision arguments. If the argument is a variable it must be declared double precision by a DEFDBL declaration or by adding the suffix #, as in X# = something. Simply declaring the argument variable double precision is not enough, as figure 1 shows. Unless one or more of the numbers on the right side of the argument's assignment statement is double precision, the right side will be evaluated in single precision and converted to double. (Note that the conversion of a single-precision 1/3 yields a peculiar double-precision value.)

Figure 2 illustrates another point. Computing 4*ATN (1) is a good method for obtaining an accurate value of pi. Note that 4.0*ATN (1.0) produces a poor value of pi while 4.0*ATN (1.0#) yields a value that is correct to 16 digits. When a function is called with a single-precision argument, the single-precision version of the function is used, even when the statement's left side contains a double-precision variable. The single-precision function result is converted to double precision.

When in doubt, overkill in the use of double-precision declarations. Similarly, declare numbers or constants in double precision to ensure that the functions are given true double-precision arguments. (Note that, as figure 3 shows, INPUT numbers to double-precision variables are handled properly.)

Comparisons show that the double-precision values are accurate, in spite of occasional round-off errors (about one every twenty values). To round a positive number properly, add 5 (decimal) or 1 (binary) to the first omitted place and truncate the number. A more intricate process than single precision, double precision is also slower; interestingly enough, it carries more than 16 digits, but no convenient way exists to display the entire value.

REFERENCES

Abramowitz, Milton and Irene A. Stegun. *Handbook of Mathematical Functions with Formulas, Graphs, and Mathematical Tables* (Applied Mathematics Series 55) Washington, D.C.: National Bureau of Standards, U.S. Government Printing Office, 1964.

Paul F. Hultquist is a professor of electrical engineering and computer science at the University of Colorado at Denver.

FIGURE 1: *Double-precision Division*

```
X#=1.0/3.0
Ok
PRINT X#
 .3333333432674408
Ok
X#=1.0#/3.0
Ok
PRINT X#
 .3333333333333333
Ok
X#=1.0/3.0#
Ok
PRINT X#
 .3333333333333333
Ok
X#=1#/3#
Ok
PRINT X#
.3333333333333333
```

FIGURE 2: *Calculating Pi*

```
10 DEFDBL A-H, O-Z
20 A=4!*ATN(1!)
30 PRINT A
40 A=4!*ATN(1#)
50 PRINT A
Ok
RUN
 3.141592979431152
 3.141592653589793
```

FIGURE 3: *Using INPUT*

```
10 INPUT A#
20 INPUT B#
30 X#=A#/B#
40 PRINT X#
Ok
RUN
? 1
? 3
 .3333333333333333
```

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PC

First new 1/4-inch cartridge since 1971

If you *don't* have data worth preserving, then the reasons for buying Cartrex's new 1/4-inch, high performance, virtually error-free tape cartridge won't mean anything

But, if you are one of the many 1/4-inch tape cartridge users that assume 3M's cartridges just *have* to be "good enough" for today's high performance tape drives, read these simple facts to understand why that isn't true anymore.

PILOTS HAVE A SAYING, "There are those who have made a wheels-up landing—and those who will." You can apply this expression to those who have lost data and those who will. Unfortunately, data loss isn't always because users haven't backed-up their hard disk. Sometimes it's because their 1/4-inch tape cartridge, where they back up their hard disk, developed hard errors—those insidious errors that tend to increase over time. That's why Cartrex has developed a 1/4-inch data cartridge for today's high performance drives that virtually eliminates errors.

The new Cartrex 1/4-inch tape cartridge is the first new tape cartridge design in almost a decade and a half. Tape drive manufacturers now have a new cartridge technology which allows them to advance beyond this previous artificial barrier.

Why a new cartridge

When 3M announced its cartridge in 1971, it was designed for a low capacity tape drive with less than 3 megabytes—2.88 to be exact. The tape was low in density—1600 bits per inch with only 4 tracks and 300 feet of tape.

The tolerances required for the tape drives of the early 1970's were fine for then, but today's tape drives require much tighter tolerance. Today's tape cartridges must work with drives that have 9 or more tracks and bit densities as high as 12,000 bits per inch on 600 feet of tape. That means capacity increases of 2,000 percent packed into the same cartridge.

The reasons that yesterday's cartridge technology simply won't work properly in today's high capacity drives is inherent in the cartridge design.

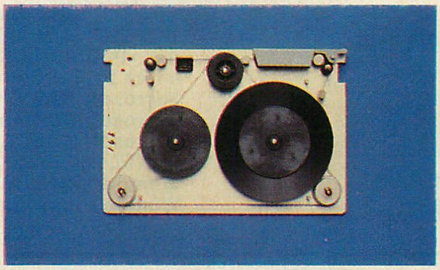
With the significant increases in capacity, the three culprits that make cartridge tolerances so important are fluctuating tape tension, redeposit nodules, and instantaneous speed variations (or ISV).

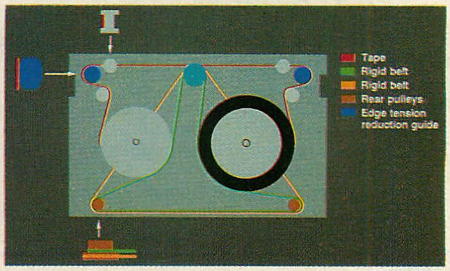
Tape Tension

Any child who has played with a magnet understands that as the magnet is separated from metal, the magnet's ability to work is decreased. So it's no surprise to find out that the closer the tape drive head is to the tape, the better the reading. This closeness is particularly important when the embedded iron filings get packed tighter in today's high density tape.

It's also important with the increase in the number of tracks. After all, you wouldn't want the head to be reading an adjacent track any more than you'd want it reading more than one magnetic representation of a bit.

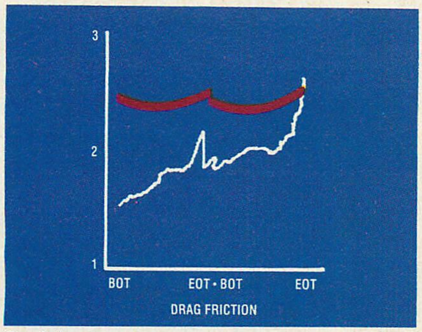
Unfortunately, tape tension historically has not been constant. As the tape unwound, the tension increased. What's important is both the *amount* and *range* of tension. A fluctuating increase or decrease in tension is as unacceptable as low tension is in the first place. As the accompanying graphs





The Cartrex cartridge design (upper left) uses the N2 principle which creates head-to-tape tension by applying a mechanical differential at the rear pulley between a stiff transport belt and a stiff tensioning belt, indicated in green and yellow in the color schematic (upper right).

The conventional 3M design applies drag at the rear pulley to create tension, which creates heat, and limits future speeds much above 90 inches per second.



Good head-to-tape tension ensures the highest probability of reliably capturing data. Fluctuating tape tension allows data loss due to head-to-tape separation and smearing redeposit nodules across the tape head. The Cartrex cartridge, compared to the conventional design, creates constant and higher tension.

show, the Cartrex cartridge has higher tension and flatter profile than the 3M cartridge. This means more reliable data across the entire tape.

Redeposit Nodules

Another reason to keep constant tension is to avoid "redeposit nodules" from smearing across your tape drive's head. What are redeposit nodules? They are the insidious flakes of tape media that break off from the edges of the tape and get dragged up to the edge of the tape head. If the tension is low, or becomes low when the tape starts or reverses, the flakes come up over the edge, get smeared over the head, and reduce its ability to read the data.

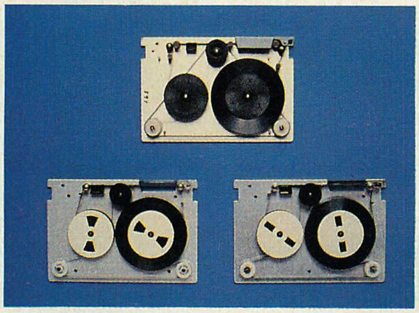
Even worse, however, is that these redeposit nodules are dragged along the surface of the tape and get embedded and packed over time. When your drive tries to read the data, the redeposit nodules act as a tent pole holding up the tape away from the head. As a result, even the best error-recognition algorithm can only tell you one thing—you've lost the data.

You might be wondering what causes the flaking in the first place. Again, it is cartridge design. The basic design uses a tape guide, shown in the accompanying illustration. The problem with this approach, is that it presupposes that the tape will always run parallel to the top and bottom caps of the tape guides. At the low speeds of 30 inches per second typical of when the 3M cartridge was designed, it was less of a problem. But at today's speeds of 90 inches per second and more, the tape wanders. When it presses against the top of the tape guide, the tape's edge pressure builds. Not only does media flake off, but you lose data due to the "coining" or "scalloping" effect.

Cartrex eliminated the cause of the tape coining or scalloping by developing a barrel-shaped roller placed prior to the tape guide. The laws of physics show that by riding on a rounded barrel, the tape will always seek the middle, reducing the tape edge pressure. This seemingly simple addition causes the tape to always enter the tape guide with zero edge pressure. In this way, the possibility of media flaking off and creating redeposit nodules is virtually eliminated.

Instantaneous Speed Variation (ISV)

Instantaneous speed variations is exactly what it sounds like—small, instantaneous changes in tape speed as it crosses the tape head. At slow tape

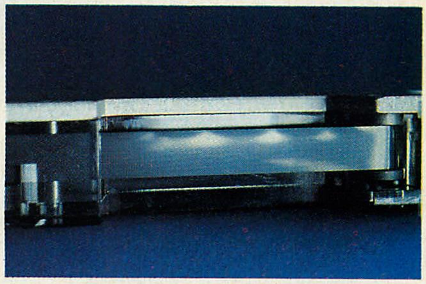


You can compare the Cartrex design on top with the conventional 3M design (lower left) and DEI, a 3M licensee (lower right). The omission of "edge tension reduction guides" (indicated in dark blue on the color schematic) on either the 3M or DEI design means that tape edge pressures will increase causing the magnetic media to flake off, smear across the tape head, and cause "redeposit nodules" to become embedded in the tape.

speeds and low bit densities—like the 1971 standard of 30 inches per second and 1,600 bits per inch—ISV wasn't as big a problem. At that time, the bits were crossing the head at 48,000 bits per second.

Today, however, the story has changed. 90 inches per second and 8,000 bits per inch mean that 720,000 bits cross the head every second. A 1,500% increase.

As you may have guessed, speed fluctuations in the 48,000 bits per second made reading data difficult for tape drive electronics. But when the electronics have to guess whether or not the bit rate of 720,000 bits per second is accurate, the electronics can become overwhelmed.



High speed tape without the "edge pressure reduction guide" seldom enters tape guides parallel to the top and bottom. The edge pressure which results creates "scalloping" or "coining" on the tape. The effect is data loss due to head-to-tape separation, flaking media that smears across the head, and "redeposit nodules" that create hard errors.

Never a Single Issue

Your tape drive seldom has the luxury of dealing with an isolated problem. It's usually a combination of ISV, redeposit nodules, and tension problems all together. Now you understand why Cartrex wanted to develop a cartridge for a market that needed a modern alternative.

Where to get it

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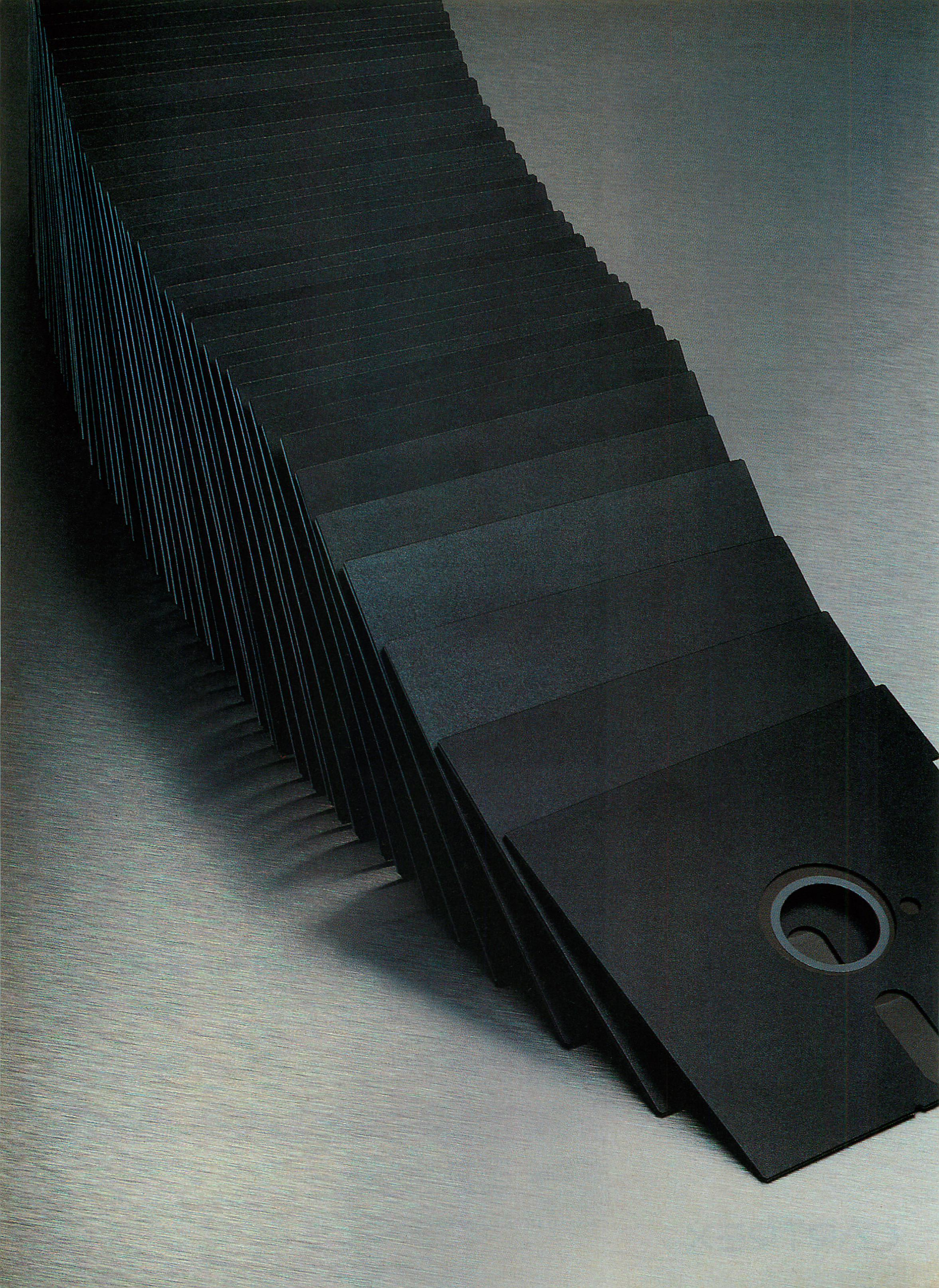


Moving up to Tape

STEVEN ARMBRUST and TED FORGERON

As the capacity of hard-disk drives increases, so does the popularity of tape backup systems. Fourteen .25-inch cartridge tape drives are examined.

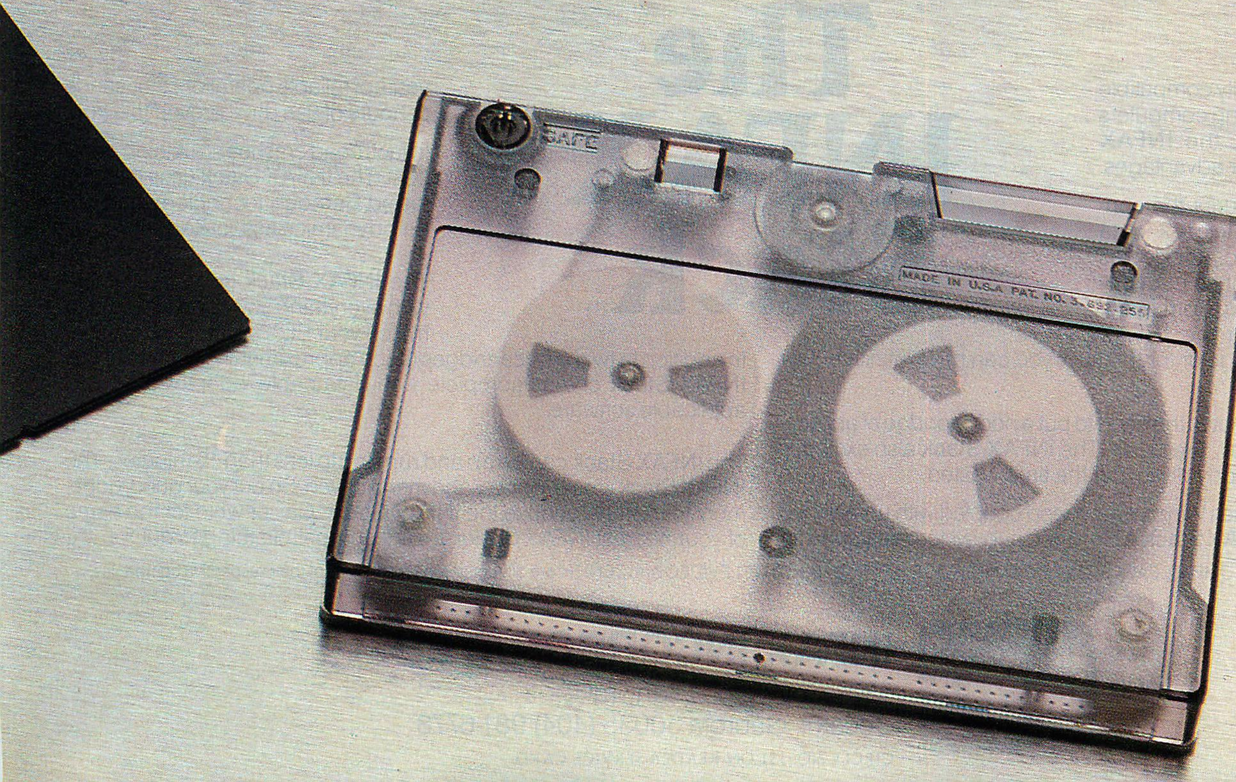
Purchasing a tape backup system is a little like buying life insurance. It's not easy to spend money for something as intangible as security, but if something goes wrong, it's nice to know protection is available—and loss of data on a hard disk is bound to happen to everyone sooner or later. In addition to the head crashes and power outages that frequently cause hard-disk failures, experimental hardware or bugs in preliminary software can also play havoc with a disk.

The DOS BACKUP command, of course, will back up hard disks onto diskettes, but practically speaking, that task is so inconvenient and time-consuming that it seldom happens. Then, when disaster strikes, users are left with no way to restore irreplaceable data.

Tape backup systems are a better answer because they are faster and, with large-capacity tapes, unattended operation is possible (no more sitting patiently and swapping 25 or 30 disks in and out of the machine). Until recently, however, tape systems had significant drawbacks: most were quite expensive, and the less expensive units lacked essential features such as file-by-file backup or restore.

Now, with 20MB and larger disk drives becoming more popular, the idea of backing up that amount of information on diskettes is so unappealing that tape backup drives, even at $1,000,

PHOTOGRAPH • LEN DeLESSIO



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In fact, head crashes are a thing of the past. The **INFAX Stack** uses the time tested Bernoulli technology and the aerodynamics associated with it.

The **INFAX Stack** comes complete with everything you need to tailor it to match your PC's exact configuration. In addition to twin disk cartridges (each approximately 8½"x11"), the **INFAX Stack** comes complete with data cable, adaptor card and applicable software.

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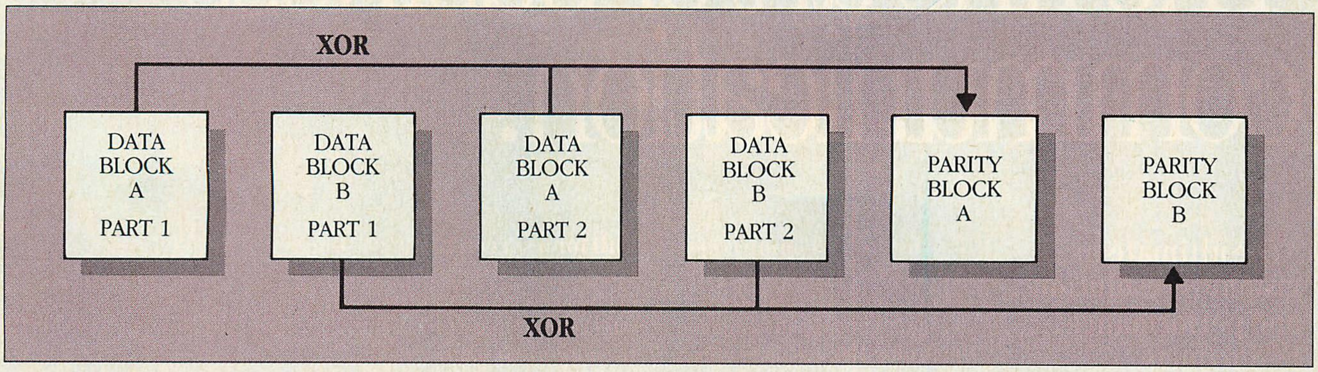
CIRCLE NO. 151 ON READER SERVICE CARD

FIGURE 1: *PC/T Format*



For every two 4KB blocks of data, PC/T writes one parity block, which is the result of performing an XOR of the two data blocks. If a read error occurs, the data can be reconstructed by XORing the parity block with the other data block. Only when damage occurs in two or more of the three associated blocks will PC/T fail to correct the errors. With interleaving of data blocks, error correction can be accomplished even when a larger section of tape has been damaged.

could become indispensible components of a microcomputer system.

One of the first choices to face buyers of tape drives is the type of media to use. At one extreme are the reel-to-reel drives that use the tapes found on mainframe computers. At the other extreme are the small InterDyne drives that use single, 1½-inch spools. In between are the .15-inch cassettes and the .25-inch cartridge tapes.

The .25-inch cartridge tape drives are the most plentiful on the PC market. They are the best match for high-end PC owners with 10MB or more of disk to back up. They are smaller and easier to use than the reel-to-reel drives, and can hold more data than the cassette or single-spool tape drives.

Although many drives are available for internal mounting, they are impractical except when used with PC/ATs or expansion chassis. Internal drives require more power than the PC's 60-watt supply can generate, and a PC/XT, with its full-height floppy and hard disk, has no room for another drive. Stand-alone units that have their own chassis and power supply, on the other hand, easily can connect to PCs, XTs, and ATs.

For these reasons *PC Tech Journal* has limited its review of tape backup systems to external drives that use .25-inch cartridge tapes. The results of evaluations of 14 products follow.

The tape systems were judged on the basis of several criteria, including ease of installation, quality of documentation, software ease of use, and the three most critical measurements: reliability, speed, and software features.

DATA INTEGRITY

The very existence of a tape drive depends on its ability to transfer data reliably from disk to tape and back without errors. If the data on the backup tape are not accurate or cannot be read again when needed, the tape drive is little more than an expensive box.

Tests were run to determine whether the drives could map out areas that could not store data reliably before writing to the tape. One test involved placing a piece of transparent adhesive tape on the magnetic media and attempting to store information on the tape cartridge. Several of the drives mapped out that part of the tape as unusable and continued operating normally. Others would not use the tape at all. Only one of the drives failed to recognize the intentional bad spot.

The .25-inch cartridge tape drives are the best match for high-end owners who have 10MB or more of disk they want to back up.

The methods used to verify accurate data differed from drive to drive, but they generally can be divided into three categories that correspond to the type of interface the tape drive uses.

Some systems, such as the Tallgrass TG-4060, use a format called PC/T, which is especially tailored for high data integrity. Tallgrass requires an extensive format pass and takes almost two hours to prepare the tape for use. However, the TG-4060 not only detects bad spots on the tape before writing information, it is able also to correct errors that occur after the tape has been written. This error-correction capability is possible because of the method the drive uses to store data on the tape.

PC/T writes one parity block for every two 4KB blocks of data on the tape (see figure 1). The parity block is created by performing an XOR of the two data blocks. If a read error occurs, the data can be pieced together by XORing the parity block and the other data block. Only when damage occurs in two or more of the three associated blocks will the TG-4060 fail to correct the errors. Tallgrass lessens this possibility by interleaving data blocks.

Other systems use an interface called QIC (for quarter-inch compatibility). QIC-interface drives are usually the fastest ones available, but they lack some of the data integrity features of other units. A QIC-interface tape drive does not bother with a formatting pass; however, erasing a tape before using it can increase the tape's reliability by cutting down on the extra noise bits that can creep into the media if the cartridge is slightly misaligned when the tape drive writes information. The QIC-interface tape erases the entire width of the tape, rather than just one track.

These drives do not use parity blocks or similar mechanisms to ensure that data already on the tape are reliable. They assume that their ability to copy information to tape accurately is enough protection against failure. QIC-interface tape drives have sophisticated controllers that check the tape for reliability as they write information. A built-in, read-after-write feature allows verifying the data on the fly. If the drive finds a bad spot on the tape, it writes the affected block of data again while the tape keeps moving. If necessary, it writes the same block of data several times until the read-after-write facility

verifies the information as correct. Because information located near bad areas of the tape is written several times, the tape-restore software also has several versions of the data to read, thereby reducing the chance of a read error.

An alternative to PC/T and QIC is the floppy disk interface used by Cipher and MicroSystems. These systems do not supply a separate tape controller; they use the PC's floppy disk adapter to control how information is written to and read from tape. These systems are not as fast as the QIC systems and do not have the extensive error-correction capabilities of PC/T, but they are usually less expensive than the others.

The tape drives that use the floppy disk interface reserve one sector out of 17 for a parity record. If a single error in the 16 data sectors occurs, the system can correct the error. If more than one error occurs, the tape system is able to detect that the errors have occurred, but it is unable to correct them.

SPEED VARIES

Besides data integrity, speed is obviously an important factor in judging tape backup systems. The speed of tape drives varies greatly. The overhead of sophisticated error-correction mechanisms to a tape drive can slow down performance—a trade-off that some people do not mind. Another hindrance to performance is the number of times the tape starts and stops during a backup session. A tape does not reach normal operating speed for approximately 300 milliseconds. Once there, most tape drives can transfer data between 60KB to 90KB per second (or between one and three minutes for an entire 10MB hard disk). Every time the tape needs to stop, another 600 milliseconds (300 to stop the tape and 300 to get it going again) pass by. This 600 milliseconds is not terribly significant in itself, but a tape drive that continually starts and stops could have other factors working to reduce its performance.

One factor is the DMA channel used by the tape controller. DMA (direct memory accessing) allows the transfer of a large block of data from a device (such as a disk or tape) directly to memory, or from memory to the device. The DMA channel is the pathway used to transfer the data between the device and memory. The 8088 processor issues a single command to start the transfer and is then free to handle other tasks during the transfer.

The IBM PC has four DMA channels: channel 0 is for memory refresh of the PC's dynamic RAM; 1 is often

Fourteen tape back-up systems, from top to bottom: a) Tallgrass TG-4060, b) Orion/Express Systems Constellation, c) Alloy PC-QICTAPE, d) Cipher FloppyTape, e) MicroSystems MT25, f) Kamerman Labs Masterflight, g) adic Model 552, h) Mountain FileSafe, i) Sysgen QIC-File, j) Everex Excel, k) Data Technology TeamMate, l) Sigma Designs Streaming Tape, m) Tecmar QIC-60, n) Maynard Maynstream.

PHOTOGRAPH • CHRISTINE ARMSTRONG/BLAKESLEE-LANE

TABLE 1: *Tape Drive Features*

TAPE DRIVE	CAPACITY	PRICE	WARRANTY	TRACKS	FORMAT	DEFAULT DMA CHANNEL	DEFAULT I/O PORT
Adic Model 552	67MB	$3,900	1 year	16	Custom	none	21CH-21EH
Alloy PC-QICTAPE	69MB	$2,995	180 days	9	QIC	3	300H-303H
Cipher FloppyTape	25MB	$1,095/XT $1,195/AT	90 days	6	Floppy disk	—uses floppy disk adapter—	
Data Technology TeamMate 60	60MB	$1,695	6 months	9	QIC	1	N/A
Everex Excel	60MB	$1,695	Ctrlr: 1 year; drive: 30 days	9	QIC	1	300H-301H
Express Systems/ Orion	45MB	$1,295 $1,555	90 days	9	QIC	1	290H-29FH
Kamerman Labs Masterflight	60MB	$1,795	1 year	9	QIC	1	200H
Maynard Maynstream 60	60MB	$1,595	1 year	9	QIC	1	370H-377H
MicroSystems MT25	25MB	$1,050	6 months	6	Floppy disk	—uses floppy disk adapter—	
Mountain FileSafe	27MB	$2,395	6 months	4	QIC	2	28CH-28FH
Sigma Designs Streaming Tape	60MB	$1,595	1 year	9	QIC	1	3E0H
Sysgen QIC-File	45MB	$1,495	90 days	9	QIC	1	290H-29FH
Tallgrass TG-4060	60MB	$1,995	90 days	11	PC/T	3	288H-28FH
Tecmar QIC-60	60MB	$2,144	90 days	9	QIC	1	338H-33BH

No standardization of features or uniformity of approach exists for the problems of backup, as is obvious from this comparison.

reserved by local area networks, but is otherwise available; 2 is used by the floppy disk drives; and 3 is occupied by the hard disk.

Most tape controllers use either DMA channel 1 or 3 for their operations. Channel 1 generally achieves higher performance, because it does not have to be shared with the disk drive. Using separate DMA channels for the tape and the disk make possible the transfer of data from disk to memory at the same time data are transferred from memory to tape, thus speeding up the entire backup operation.

A noticeable slowdown occurs when the tape drive must share DMA channel 3 with the hard disk. Because no two devices can use the same DMA channel at the same time, the disk and tape software must perform operations sequentially rather than in parallel. Therefore, the tape drive usually is stopped while a large block of data is read into memory from disk. Then, when the data are transferring to tape, the disk is stopped.

Some tape drives use DMA channel 2, but they either do not allow backup from floppy disk to tape or they share the channel with the floppy drives. Because backing up a floppy disk is rarely a problem, sharing the channel with the floppy controller seems a minor inconvenience when compared to the speed increase resulting from separate channels for the tape and the hard disk.

Even if separate DMA channels are used for disk and tape I/O, not all drives can achieve optimum performance. The tape software must be fast enough to keep pulling data from disk into a memory buffer while the tape drive is writing to tape. Then, the software can keep sending data to the tape drive without ever having to stop the tape. This process is called *streaming*. If the software is not fast enough to keep the memory buffer full, the tape drive will be forced to stop (or continue to run and waste tape) and wait for the software to catch up.

The majority of the drives tested were not able to stream the tape consistently, even when they had their own DMA channel. Of the drives that did stream the tape, Kamerman Labs, Sigma Designs, and Tecmar were among the fastest systems. The MicroSystems and Cipher drives, which use the floppy controller card instead of a separate tape controller, also took advantage of tape streaming and performed credibly.

ESSENTIAL SOFTWARE

The basic level of tape software is the image backup and restore. An image backup copies information bit by bit from the hard disk to the tape, without regard to operating-system formatting or file structures. Therefore, disks partitioned for other operating systems, such as XENIX or CP/M-86, can be copied.

One disadvantage of image backup and restore is that data usually cannot be copied back to disk one file at a time; the entire disk must be restored. Another disadvantage of most image backups is that they copy not only the information from the disk, but also the bad track mappings. This is acceptable if the data are to be restored to the same disk. When restoring to a different hard disk, however, the bad tracks of the second disk are ignored and valid data are copied into these unreliable areas, possibly resulting in read errors

DEFAULT INTERRUPT	DMA CHANNEL, I/O PORT, AND INTERRUPT	ERROR CORRECTION	CONTROLLER CARD SUPPLIED	RUNS ON PC/AT	TYPE OF SOFTWARE	DIAGNOSTICS SUPPLIED	SUPPORTS BATCH FILES	MULTIPLE BACKUPS ON ONE TAPE
None	No	Yes	Short	Yes	Menu	Yes	Yes	Yes
None	Yes	No	Short	Yes	Menu	No	Yes	Yes
—uses floppy disk adapter—		Yes (single)	None	Yes	Command	No	Yes	Yes
4	Yes	No	Short	Yes	Both	No	Yes	No
3	Yes	No	Long	Yes	Menu	Yes	Yes	No
None	No	No	Long	Yes	Both	Yes	Yes	Yes
3	No	No	Long	Yes	Command	No	Yes	Yes
2	No	No	Short (or piggyback card)	Yes	Both	No	Yes	Yes
—uses floppy disk adapter—		Yes (single)	None	Yes, with ctrlr. card	Menu	No	Yes	Yes
None	Yes	No	Short	Yes	Both	No	Yes	Yes
None	DMA only	No	Short	Yes	Both	Yes	Yes	Yes
None	No	No	Long	Yes	Both	DMA test	Yes	Yes
3	No	Yes	Short	Yes	Command	No	Yes	Yes
None	Yes	No	Short	Yes	Both	No	Yes	Yes

when the user attempts to access those files. Only Tecmar and Everex provide a mechanism for avoiding bad tracks when restoring to a different hard disk. The Tecmar method guarantees data integrity only if the second disk has the same or fewer number of bad tracks.

A more flexible level of tape software, also available on most tape drives tested, allows file-by-file backups and restores. This process is usually slower than image backups and restores, which is why most vendors include both choices. The file-by-file method usually can work only with DOS files and not non-DOS partitions. Most file-by-file software provides several options for choosing which files to back up or restore. All of them allow selecting individual files or all subdirectories in a certain directory. Many also allow backing up only the files that have changed since the last backup—a convenient way to shorten the time required to back up a disk. Some software allows backing up files modified after a particular date (or those modified between dates). The Everex, adic, and Alloy systems also allow backing up all files except those specified. Options for restoring are usually the same as for backing up. An additional option included with many systems prompts the user for permission to restore files if the files already exist on the disk.

Ideally, tape software should be flexible enough to allow users to back up their hard disks in the fast, image mode and restore the same data in the more powerful file-by-file mode. However, for most drives, the image and file-by-file operations are incompatible. Of the drives tested, only a few can do a file-by-file restore from an image backup. Some tape drives, such as Kamerman Labs' Masterflight, avoid the problem by performing file-by-file backups almost as quickly as image backups. Others, such as the Maynard Maynstream, provide only the file-by-file capability, but at competitive speeds.

> *Some tape software packages allow users to choose tape options from nicely laid out menus, others from DOS-like commands.*

Another important feature (especially for the frugal) is the number of backups a single tape can contain. Because many of the drives tested can store up to 60MB on a single tape, and few users have 60MB disks, one tape can be used for several backup sessions. Most of those tested allowed several sessions (or datasets) to be copied to a single tape. Tallgrass and adic provide methods to replace existing tape files. This capability arises because of the tape formats they use, not because of any special software. By the same token, if a hard disk contains more data than can fit on a single tape, multitape backups are essential.

The operator interface is also an important software issue. Some tape software packages allow users to choose tape options from nicely laid out menus; others from commands that are entered in the same way as DOS commands. Some of the systems provide both kinds of interfaces.

The menu interface allows novices to back up their systems without being forced to pore through intimidating ref-

TABLE 1: *Tape Drive Features (continued)*

TAPE DRIVE	BACKUPS SPAN MULTIPLE TAPES	FORMAT	IMAGE BACKUP	IMAGE RESTORE	FILE BACKUP	FILE RESTORE	FILE RESTORE FROM IMAGE BACKUP
Adic Model 552	Yes	Yes	No	No	Yes	Yes	No
Alloy PC-QICTAPE	No	Yes	No	No	Yes	Yes	No
Cipher FloppyTape	Yes	Yes	No	No	Yes	Yes	No
Data Technology TeamMate	No	No	Yes	Yes	Yes	Yes	Yes
Everex Excel	No	No	Yes	Yes	Yes	Yes	Yes
Express Systems/ Orion	No	No	Yes	Yes	Yes	Yes	No
Kamerman Labs Masterflight	No	No	Yes	Yes	Yes	Yes	No
Maynard Maynstream 60	Yes	No	No	No	Yes	Yes	No
MicroSystems MI25	Yes	Yes	No	No	Yes	Yes	No
Mountain FileSafe	No	No	Yes	Yes	No	N/A	Yes
Sigma Designs Streaming Tape	Yes	No	Yes	Yes	Yes	Yes	No
Sysgen QIC-File	No	No	Yes	Yes	Yes	Yes	No
Tallgrass TG-4060	No	Yes	Yes	Yes	Yes	Automatic	No
Tecmar QIC-60	No	No	Yes	Yes	Yes	Yes	No

erence manuals. Also, because tape software will probably be used far less than most other software (once a day, at most), menus are an easy way to jog the user's memory. The drawback of menu systems is that tape operations are hard to automate. Setting up batch files to work with menu-driven software is inconvenient, if not impossible.

On the other hand, tape software supplied as individual commands is easy to include in batch files or automated processing. The commands are similar in syntax to other DOS commands, but a trip to the reference manual may be necessary until the user is familiar with the software. Whether the menu or command interface is better depends on the person using the system. Most tape drive suppliers provide both kinds of user interfaces.

Some of the systems include software additions worth noting. Alloy's PC-QICTAPE includes a module to allow programs to access tape functions. Adic's Model 552 has a WAITUNTIL program to set up a backup session for a later time, usually in the middle of the night when no other computer activity takes place. Kamerman Labs includes a user-name/password capability to protect sensitive data in its Masterflight. The Tecmar QIC-60 and Everex Excel avoid bad tracks when performing an image restore on a new disk. The Express/Orion unit has a MIMIC feature to store and replay menu keystrokes, and it includes commands that improve backup performance by changing the hard disk's interleave factor.

THE TESTING PROCESS

With one exception, all the tape drives in this article were tested for at least five hours each under identical conditions. An IBM PC with a 10MB hard disk in the expansion chassis and 320KB of memory (representing a typical system) was used for the tests. The operating system was DOS 3.1 with BUFFERS set to 20 in the CONFIG.SYS file.

The hard disk was filled until the DIR command indicated 0 bytes free. The disk then contained 28 directories and 960 user files. Unless otherwise mentioned, all backups (both image and file-by-file) were performed with the disk in this condition.

One drive, Mountain's FileSafe, would not work with this configuration, so was set up with a 20MB Microscience hard disk and no expansion chassis. The same amount of data (10MB) was backed up and restored, but the differences in disk sizes might have affected the results slightly.

A higher value was placed on performance, error handling, features, and lack of bugs than on price, documentation, or ease of use. Other users might place more importance on data integrity; or some might need a system that runs off the floppy controller instead of its own controller; price often is of primary importance. Therefore, the ratings presented here are only a starting point for selecting a tape drive.

The results of the tests for each tape drive are discussed individually below. The order in which the drives are listed is based on the authors' personal preferences after all tests were completed. Table 1 compares the features of the tape drives. Table 2 lists figures for the performance benchmarks. Table 3 summarizes the conclusions.

Tecmar QIC-60. The QIC-60's combination of quality hardware, software, and documentation put it at the top of the class. Its cabinet is attractive, although with the tape standing on edge, it looks different than any of the other units. It has LEDs that indicate track number, read,

RESTORE TO DIFFERENT DIRECTORY	VERIFY	DIRECTORY OF TAPE	RETENSION	HELP	SUBDIRECTORIES	MODIFIED FILES ONLY	EXCLUDE SPECIFIED FILES	DATE
Yes	No	Yes	Automatic	No	Yes	Yes	Yes	Yes
Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Yes	Yes	Yes	Automatic	Yes	Yes	Yes	No	Yes
Yes	Yes	Yes	Yes	No	Yes	Yes	No	Yes
Yes	Yes	Yes	Yes	No	Yes	No	Yes	Yes
No	No	Yes	No	No	Yes	Yes	No	Yes
Yes	Yes	Yes	Yes	No	Yes	Yes	No	Yes
No	Yes	Yes	Yes	No	Yes	Yes	No	Yes
Yes	Yes	Yes	No	Yes	Yes	Yes	No	Yes
No	Yes	Yes	Yes	No	Yes	No	No	Yes
Yes	Yes	Yes	Yes	Yes	Yes	No	No	No
Yes	Yes	Yes	Yes	No	Yes	Yes	No	Yes
Yes	Yes	Yes	Automatic	Yes	Yes	Yes	No	No
Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes

write, forward, reverse, and selected. This is a half-height unit, and its cabinet is wide enough to support another half-height drive, such as a hard disk.

The QIC-60 is not the fastest tape drive tested, but it comes close. It contains both menu- and command-driven interfaces that are full-featured and easy to use. The menu software is geared especially for novices. One nice feature of the software is the report it issues after finishing a backup or restore, including the total number of bytes transferred and the amount of time taken to accomplish the transfer.

Installation is easy. Hardware installation involves inserting a controller card and connecting a cable. A menu-oriented utility program performs the software installation. The two minor problems encountered with the Tecmar drive both involve installation. First, the install program forces the tape software to be placed in a first-level directory. Second, the install program needs to add information to the CONFIG.SYS file, but cannot if the hard disk is totally full. In that case, the old CONFIG.SYS file is truncated to 0 bytes and the information in it lost. (It was later discovered that the program had been trying to set the number of buffers to 17, but CONFIG.SYS was already set up for 20.)

Tecmar's documentation is thorough, well-written, and attractive, although it is delivered without a binder. It is not overly technical, but, at the same time, it does not leave out any important details.

The Tecmar QIC-60's combination of quality hardware, software, and documentation earn it a place at the top of the class.

Sigma Designs Streaming Tape. This tape drive has speed and excellent drive diagnostics among its features. Unfortunately, however, its user software is lacking in a few important areas.

The Sigma cabinet is well-built and attractive, and it features heavy-duty flat cables for connecting the drive. Hardware installation is the standard process, inserting a short controller card and connecting cables. Software installation is made easy by a utility program that allows selection of software parameters (such as screen border color, input batch files, and output log files) and hardware parameters (such as DMA channel, I/O port, and DMA buffer size).

Performance is excellent, especially for image backups and restores. File-by-file backup is also reasonably fast, but file-by-file restore is slower than some of the other high-speed systems.

Sigma's Streaming Tape comes with both menu- and command-oriented software; the menu is very easy to use. During tape sessions the system keeps the user informed of its progress. Unfortunately, some of the file-selection criteria, such as choosing only modified files to back up or choosing files by date, have not yet been implemented. However, those options are flagged in the documentation for inclusion in the next release.

The diagnostic program supplied with the Sigma tape drive is one of the best in the group. It performs complete diagnostics on the drive and the cartridge, reporting to the user on tape size, rewritten blocks, soft read errors,

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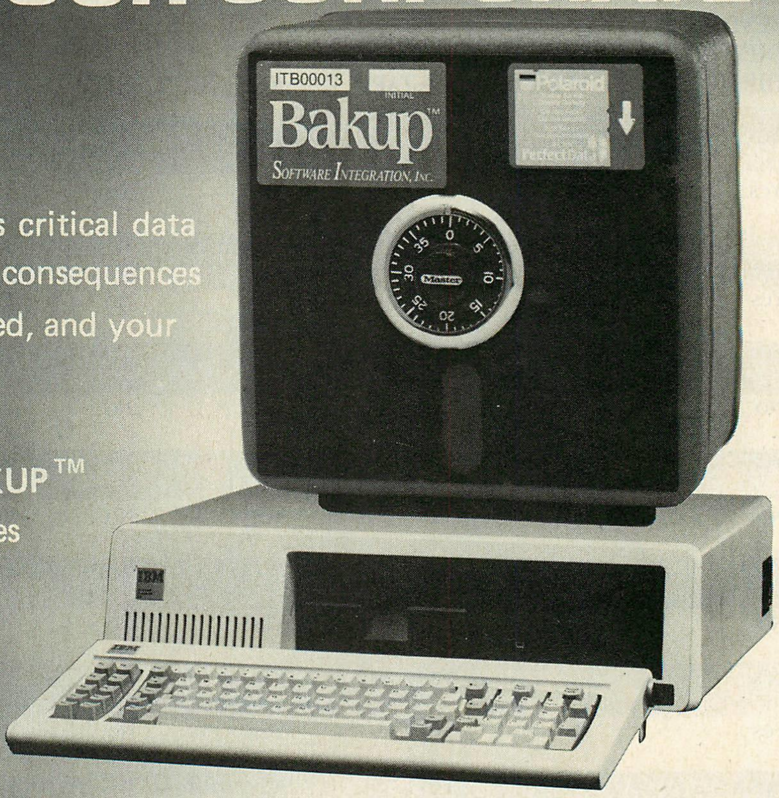

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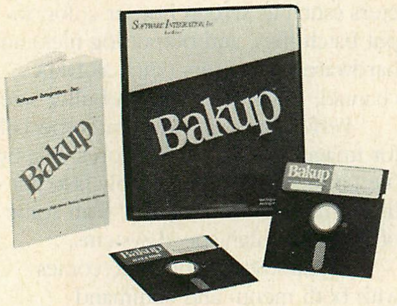

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and comparison errors. It does not, however, warn the user that it plans to write over the tape during the diagnostic process. During testing, an entire backup session was lost because of this.

The user manual is so poorly organized and laid out that finding information is almost impossible. Sigma makes up for its poor documentation in part by providing an on-line tutorial.

When the software is modified to allow more flexibility in selecting files to back up and restore, and if the company would put more effort into the documentation, Sigma might be able to compete head-to-head with Tecmar.

Kamerman Labs Masterflight. Two special features make this tape drive one of the best tested. First, the chassis itself is the same length and width as the PC's system unit, but only half the height. Therefore, it can fit easily above the system unit without raising the monitor to skyscraper levels. The chassis also has room to support two more half-height

Masterflight cannot be recommended to novice users until Kamerman Labs writes a real manual and reconfigures the I/O port.

TABLE 2: *Performance Tests*

TAPE DRIVE	TAPE FORMAT	IMAGE BACKUP	IMAGE RESTORE	FILE BACKUP	FILE RESTORE
Adic Model 552	35:06	N/A	N/A	25:43	102:00
Alloy PC-QICTAPE	1:01	N/A	N/A	24:30	80:44
Cipher FloppyTape	37:30	N/A	N/A	11:48	25:24
Data Technology TeamMate	N/A	—[a]	—[a]	26:48	34:36
Everex Excel	N/A	2:24	3:38	31:20	48:05
Express Systems/ Orion	N/A	2:39	13:54	20:58	31:40
Kamerman Labs Masterflight	N/A	2:51	2:51	4:49	27:21
Maynard Maynstream 60	N/A	N/A	N/A	6:27	22:11
MicroSystems MT25	37:52	N/A	N/A	11:59	28:18
Mountain FileSafe[b]	N/A	5:20	4:44	N/A	45:38
Sigma Designs Streaming Tape	N/A	2:48	2:48	10:38	28:16
Sysgen QIC-File	N/A	2:47	17:28	21:37	31:53
Tallgrass TG-4060	119:00	12:55	13:42	35:06	77:00
Tecmar QIC-60	N/A	3:55	4:38	10:53	11:55

All times are given in minutes:seconds.

[a] Although the TeamMate promised image backup and restore, the image backup option did not work. Therefore neither of the image options was timed.

[b] The Mountain would not work on the standard test machine. Its benchmarks were obtained by connecting it to a PC with a 20MB Microscience hard disk (which contained 10MB of data).

These tests measure each drive's performance when executing a series of standard tape operations. N/A means that the tape drive does not support that operation.

peripherals. In addition, Kamerman includes a lock similar to the one on the AT system unit and enough power outlets on the back panel to connect monitors and printers. Surge protection equipment is also available.

Speed is the other nice feature of Masterflight. For image backup and restore, it is one of the fastest units tested, approaching the theoretical maximum speed possible for the hardware.

Another valuable feature, especially for those who manage sensitive data, is the password feature. It allows users to establish a user name and password for each data set they back up. To restore files from the data set, the same password must be supplied. Even if tape cartridges walk off on their own, passwords allow users to feel more secure about the privacy of their data.

On the other hand, Masterflight's software is not particularly easy to use. It has no menu interface, only commands. The manual's descriptions are obscure and hard to piece together. A trial and error process is necessary to figure out how some of the options work. The software has the unnerving trait of ceasing all signs of life while the program decides what to do next. It begins the file-by-file process by examining the directory structure of the disk and figuring out just how to place the files on the tape; after a few seconds of activity, the disk is silent, the tape is unmoving, and no words of explanation appear—sometimes for several minutes. Experience says that the program has crashed, but then it springs to life without warning and completes the operation. Once the backup process gets rolling, the screen continually updates a percentage display that shows how much of the backup is complete. However, the program does not display file names as it backs up or restores.

The installation process is easy. It involves simply inserting and connecting the controller card and copying several files from a diskette to a directory. However, the tape controller card is configured to use I/O port 200H, the port used by the IBM game adapter (which our system contained) and other game adapters such as the one available with the AST SixPak. After installation, the tape drive would not work, and the port conflict actually wounded a memory board as the tape controller and game adapter played bus wars. Kamerman Labs confirmed the problem; it plans to switch the default configuration to I/O port 280H.

The documentation received for evaluation with Masterflight was a preliminary copy that was rudimentary at best. It consisted of a few 8½-by-11-inch pages printed on a letter-quality printer and stapled together. The explanations of the commands were not very clear, and the documentation omitted mentioning the port addresses and DMA channels used. This lack of information can cause problems during installation.

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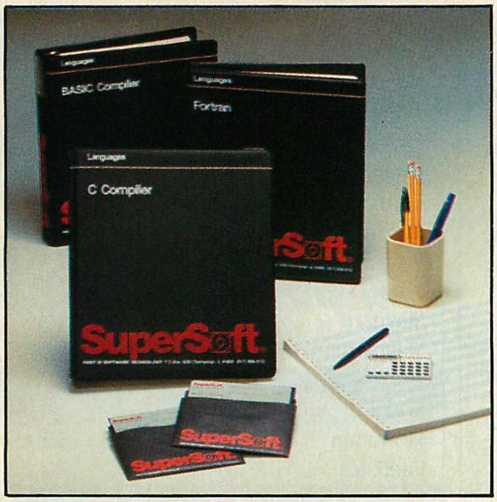

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TABLE 3: *Recommendations*

TAPE DRIVE	EASE OF INSTALLATION	DOCUMENTATION	PERFORMANCE	EASE OF USE	ERROR HANDLING	FREEDOM FROM BUGS	FEATURES
Tecmar QIC-60	Good	Excellent	Good	Excellent	Good	Good	Good
Sigma Designs Streaming Tape	Good	Fair	Excellent	Excellent	Good	Good	Fair
Kamerman Labs Masterflight	Fair	Poor	Excellent	Fair	Good	Good	Good
Cipher FloppyTape	Excellent	Excellent	Fair	Good	Good	Good	Fair
Tallgrass TG-4060	Good	Good	Poor	Good	Excellent	Good	Good
MicroSystems MT25	Excellent	Good	Fair	Good	Good	Good	Fair
Adic Model 552	Good	Good	Poor	Good	Excellent	Fair	Good
Sysgen QIC-File	Fair	Good	Fair	Good	Good	Good	Good
Maynard Maynstream 60	Good	Good	Good	Good	Fair	Fair	Fair
Express Systems/Orion	Good	Fair	Good	Good	Fair	Good	Good
Everex Excel	Fair	Fair	Fair	Good	Good	Fair	Fair
Mountain FileSafe	Good	Good	Good	Good	Poor	Poor	Good
Alloy PC-QICTAPE	Good	Good	Poor	Good	Fair	Fair	Fair
Data Technology TeamMate	Good	Poor	Poor	Fair	Good	Poor	Fair

After testing all 14 tape drives, the authors concluded that the Tecmar, Sigma Designs, and Kamerman Labs units are the clear winners; Cipher, Tallgrass, MicroSystems, adic, Sysgen, Maynard, Express Systems/Orion, and Everex deserve honorable mention; users should wait for the next release before considering the Mountain, Alloy, and Data Technology systems.

This tape system is attractive and well-designed with expansion capabilities. The software is extremely fast and full of features, but has no fancy human interface. The manual is barebones. Masterflight cannot be recommended to novice users until Kamerman Labs writes a real manual and reconfigures the I/O port. By the time this article appears in print, both of those tasks should be complete.

Cipher FloppyTape. The Cipher tape backup drive uses the floppy disk controller, limiting the amount of the data that can be stored on a tape (25MB in this case, but it has the capability of continuing the backup on successive tapes) and limiting the system to installation on only those computers that have an external connector on their floppy disk adapters (the AT and the Compaq portable, for example, do not have this connector). Using an existing adapter reduces the cost of the tape system, saves a card slot, and allows the equipment to be transported easily from computer to computer.

FloppyTape (and others controlled by the floppy disk adapter) offers some error correcting capabilities, although they are not as extensive as those offered by Tallgrass or adic. Data are recorded in sectors, and 1 out of every 17 sectors is reserved for data checking. A single error in the 16 data sectors can be corrected. Multiple errors are detected and flagged to the user.

However, this drive could not format a damaged tape (the one with transparent tape on part of the surface). It recognized the tape as bad, but could not map out the area as unusable. Instead it displayed a message indicating the tape was bad and refused to use it.

Hardware installation is as simple as plugging in a new display monitor. A cable must be plugged into the external connector on the computer's floppy disk adapter. The cover of the system unit does not even need to be removed. Software installation involves simply copying files to a directory.

FloppyTape is useful for those who want to back up several PCs without reinstalling controller cards or purchasing separate cards for each computer.

Performance is surprisingly good for a tape drive that does not have its own controller. Almost 40 minutes is required to format a tape, but as soon as that lengthy process is complete, backup and restore operations proceed with reasonable speed. All FloppyTape's operations are performed file-by-file and are fast enough to eliminate the need for image operations.

The tape software offers a pure command-oriented interface; the commands are consistent with ordinary DOS command syntax.

The documentation slips into the IBM *Guide to Operations* or *DOS* manual. Its format matches that of the IBM manuals, even down to the text fonts and the margins. Only the light blue color of the pages distinguishes them from their IBM counterparts.

FloppyTape should be considered by those who have 20MB or smaller hard disks and who have no card slots to spare. It is also useful for those who want to back up several PCs without reinstalling controller cards or purchasing a separate card for each computer.

Tallgrass TG-4060. The Tallgrass tape system trades speed for data integrity.The end result is a high-quality unit, but one whose performance is so slow that some users might be deterred from backing up their data often enough to justify its purchase. The drive comes in a fine cabinet, as should be expected from an established company like Tallgrass. The hardware and software installation processes are not difficult.

The feature Tallgrass advertises most about its tape drive is the PC/T tape format that allows automatic correction of errors after the tape has been

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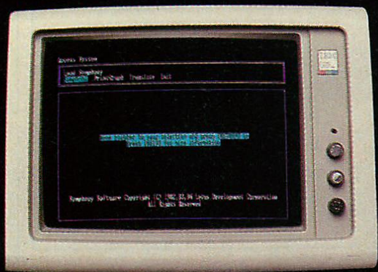
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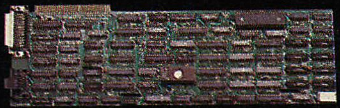
The Edge  The Plain Facts:

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—132 columns by 44 rows in monochrome	✓		✓			✓
—132 columns by 25 rows in color	✓		✓			
Runs Lotus 1-2-3™ and Symphony™ in high resolution monochrome graphics:	✓		✓		✓	✓
—in 132 columns by 25 rows	✓		1-2-3 only			✓
—in 132 columns by 44 rows	✓					✓
Runs Lotus 1-2-3™ and Symphony™ in High Resolution color:	✓		✓			
—16 colors, 320 x 200	✓		✓			
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Light Pen Connector (standard)	✓	✓	✓		✓	
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recorded—even errors up to 4KB in size. This format also allows the user to update files on tape (copy a new file over an old file) without creating an entire new dataset on tape. However, before a tape can be used, TG-4060 requires an interminable amount of time for formatting—almost two hours for a 60MB tape. Backup and restore operations are also painfully slow.

One other problem with the Tallgrass drive is that it must be turned off in order to boot the PC.

The software provides only a command-oriented interface, but the interface is similar to the normal DOS commands, so learning the commands is easy. A help command provides the appropriate memory jog when necessary.

The TG-4060 documentation supplies valuable information, but it is not the attractive package that the hardware is. This is an intimidating book, larger than necessary because it also documents a Tallgrass hard disk.

The Tallgrass unit should be considered an alternative by people who transfer tapes from location to location, or who otherwise subject the tapes to harsh conditions. However, this unit's performance is much less than should be expected for the price.

MicroSystems MT25. The MicroSystems and Cipher drives are almost identical in terms of hardware and software (although the software interface is different). Like Cipher's FloppyTape, the MicroSystems MT25 uses the floppy disk controller instead of providing a separate tape controller. This limits the amount of data it can store on a tape and limits its use to computers that have an external connector to the floppy disk adapter. Even though this drive can store only 25MB of data on a single tape, it has the capability of continuing a backup on multiple tapes.

Installation is as easy as it is with the Cipher. The hardware can be installed without removing the cover of the computer's system unit. The user interface is a hybrid of menu and command operations. The menu aspects make the software easy to use, but an AUTOTIP feature allows tape operations to be controlled from batch files.

The documentation is slim, but it is well done and seems to contain enough information to use the equipment.

Like Cipher, MicroSystems offers a tape drive that should be considered by those with card slot shortages and 20MB or less hard disks, as well as by those who want to back up several hard disks without card-swapping. Users who prefer a menu interface rather than a command interface should choose MT25 over FloppyTape.

Adic Model 552 Data Library. This product could be considered the army tank of tape backup systems. It's expensive, it's longer and almost as wide as the PC's system unit, and it weighs enough to include a 60MB hard disk in the cabinet too—but it is all armor plating, circuitry, and tape drive.

Model 552 is the one to choose for anyone who stays awake nights worrying whether valuable data are safe from disk crashes. Its tape formatting is similar to that of the Tallgrass TG-4060, allowing it to correct errors that occur after data have been written to tape. It has extensive tape diagnostics, an RS-232 port for use by repair technicians, and a thorough fault analysis and diagnostics section in the manual. With all of this protection, even the most paranoid hard-disk user should feel safe.

Data security takes priority over speed in this tape system. The software includes no image backup and restore operations, and the file-by-file operations are among the slowest tested. However, the product includes a nifty program that can make the tedious backup process a little easier to accept. WAITUNTIL allows the backup program to be invoked now but executed later in the day, presumably at night when the computer is idle.

Adic's Model 552 is the right choice for anyone who stays awake nights worrying whether valuable data are safe from disk crashes.

Hardware installation is simply a matter of inserting the controller card and connecting a cable. The manual glosses over this process in less than a page, so those who have never installed cards in their computers before might feel intimidated. Software installation involves copying files and modifying the CONFIG.SYS file. No batch file exists to automate the process.

Adic provides backup and restore software that includes most of the standard features. In addition, all DOS commands work with the tape drive. For example, the DOS COPY command can be used to copy a file from disk to tape, or vice versa. A program can even be executed from tape. To permit this DOS environment, an extensive tape formatting process is required, which divides the tape into two 32MB volumes or four 16MB volumes for use with DOS. Model 552 requires the use of 3M factory-preformatted tapes.

The Model 552 manual, which is printed on a letter-quality printer, is nicely organized and easy to read. The comprehensive theory of operations, service information, and tape format descriptions are more than most users need to read, but like everything else about this tape system, just having all that detailed information at hand adds to the feeling of security.

It is hard to imagine a sturdier, more secure system than Model 552. The one-year warranty assures that if the unit needs service, adic will provide the owner with a loaner unit by 10 a.m. the next day. Its large, nonstandard footprint, which stems from its first design for use with minicomputers, allows the addition of a hard disk with up to 134MB in capacity. It works well with the PC, if extremely slowly.

Sysgen QIC-File. The Sysgen tape system is more compact than some of the others. Its cabinet barely surrounds the tape drive, and instead of being mounted inside the cabinet, its small power supply hangs on the power cable in back of the drive. The power cable ends in a multi-plug affair that plugs into the PC's monochrome monitor outlet and provides another outlet for the monitor cable. Because of this connection, the tape system draws five watts of power from the PC's power cord.

This hardware layout results in a more complicated installation process than for some of the other drives. A full-length controller card must be inserted, power cables (the drive's and the monochrome monitor's) must be changed around, and a large flat cable must be attached between the controller and the drive. The cable is extremely inflexible and difficult to attach. Use of a traditional D-shell connector would have made this procedure easier.

Software installation, which is not so difficult, involves copying files into a directory (or setting up a CONFIG.SYS file, if the system also uses a print spooler or is part of a local area network). The installation instructions are slightly confusing because the same manual discusses both internal and external versions of the Sysgen drive.

The software includes both image and file-by-file operations. The image backup is extremely quick and the other operations also are fast. Both menu-

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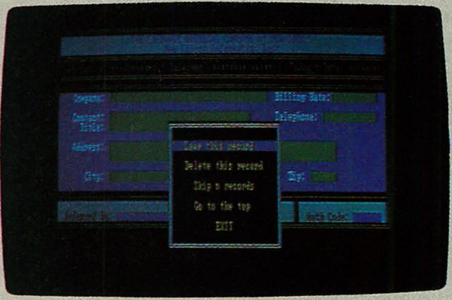

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and command-oriented interfaces are available. In addition to the usual features, Sysgen offers a file compare option that is able to compare files on tape with the same files on disk. The software can restore files into the current directory regardless of the subdirectory structure recorded on tape.

QIC-File presented one problem during testing. The software creates temporary files on the disk it is backing up, but when the disk is completely full, as it was for testing purposes, the program sends an "Unable to Write to Temporary File" message. When 50KB of space was made available on the disk, the message changed to "Operation Error: Write File Error." Finally, with 75KB of space, the software was able to work. Although the documentation warns that the software needs space for temporary files, it does not say how much. Furthermore, neither error message is described in the manual. Apart from these shortcomings, the manual provides the necessary information. It consists of attractive, typeset pages that can be inserted into the IBM *Guide to Operations* manual.

This tape drive should be considered by those with severe space limitations who do not mind fumbling around a bit with the awkward connections. Its performance is adequate.

Maynard Maynstream 60. This is another drive with a well-designed cabinet. It is portable, with a convenient carrying handle and snap-on cables. The intention is to use a single tape drive to back up several PCs; the catch is that each computer still needs its own short controller card or a piggyback module that plugs into Maynard's Sandstar series controllers. Maynard markets these controller cards separately.

To ensure Maynstream's portable nature, hardware installation has to be easy, and it is—insert the short controller card and plug in the tape drive. Software installation also is made easy with an install program that copies files and sets CONFIG.SYS parameters.

The controller card is set up to use DMA channel 1. Neither the manual nor the installation software hints at how to change that setting, if it is possible.

Maynstream software contains both a menu and command interface. It provides file-by-file backups and restores only; it has no separate image operations. Performance times are not the best in the group, but they are good for a system that lacks image operations.

A couple of limitations are apparent in the software. It allows only a single dataset per tape, and it does not permit restoring of data to a different subdirectory than was used for backup. In addition, two bugs were discovered in the software, both involving the backup procedure. First, the manual lists a command that backs up a disk and all of its subdirectories. When

```
tbackup c:\ /s
```

was entered, the program failed to back up and returned an internal consistency error. However, when the command was changed slightly to

```
tbackup c:\*.* /s
```

the program was able to back up the disk with no problem.

The other bug occurred when trying to back up data to a tape containing a bad spot. During the backup, the software returned a "code -6" error and refused to continue. Unfortunately, instead of describing the problem, the manual advises the user to consult the dealer when such an error occurs.

Despite lacking some important information, the documentation is laid out well and is of high quality. A pocket reference and quick installation guide are included for convenience.

Maynstream's performance times, while not the best in the group, are surprisingly good for a system that lacks image operations.

Express Systems/Orion Constellation 60 ETP. The Express Systems tape drive is identical to the Constellation 60 ETP sold by Orion Computer Products. Express Systems puts its own label on the drive and sells it primarily through mail-order channels. The half-height drive comes in a PC-styled cabinet with room to install another half-height drive.

Hardware installation is typical of the other systems tested: a controller card is added and a cable is connected between the drive and the card. The manual, however, describes only internal drives and provides no instructions specifically for external installation. Software installation is simplified by the presence of a batch file that both modifies the CONFIG.SYS file and copies the tape software to disk.

The software, which offers both menu and command interfaces, operates much like Sysgen's software. Both image and file-by-file operations are available; image backup times are among the fastest of the systems tested. Also included with the software is a MIMIC function that allows users to store keystrokes for more convenient use of the menu software. MIMIC copies keystrokes into a file and uses the DOS I/O redirection feature to allow this file to be input to a later tape session. The MIMIC feature is in addition to the tape commands that can be inserted into an ordinary batch file.

Two other programs are available to help speed the backup process. They are special disk-formatting programs that set the hard disk's interleave factor to 5 (for a PC) or 3 (for an AT). The interleave factor indicates the number of physical disk sectors between sequential logical sectors. Reformatting the disk with an appropriate interleave factor that allows the disk to fill the data buffer most effectively can guarantee that the tape will stream during all image backup operations.

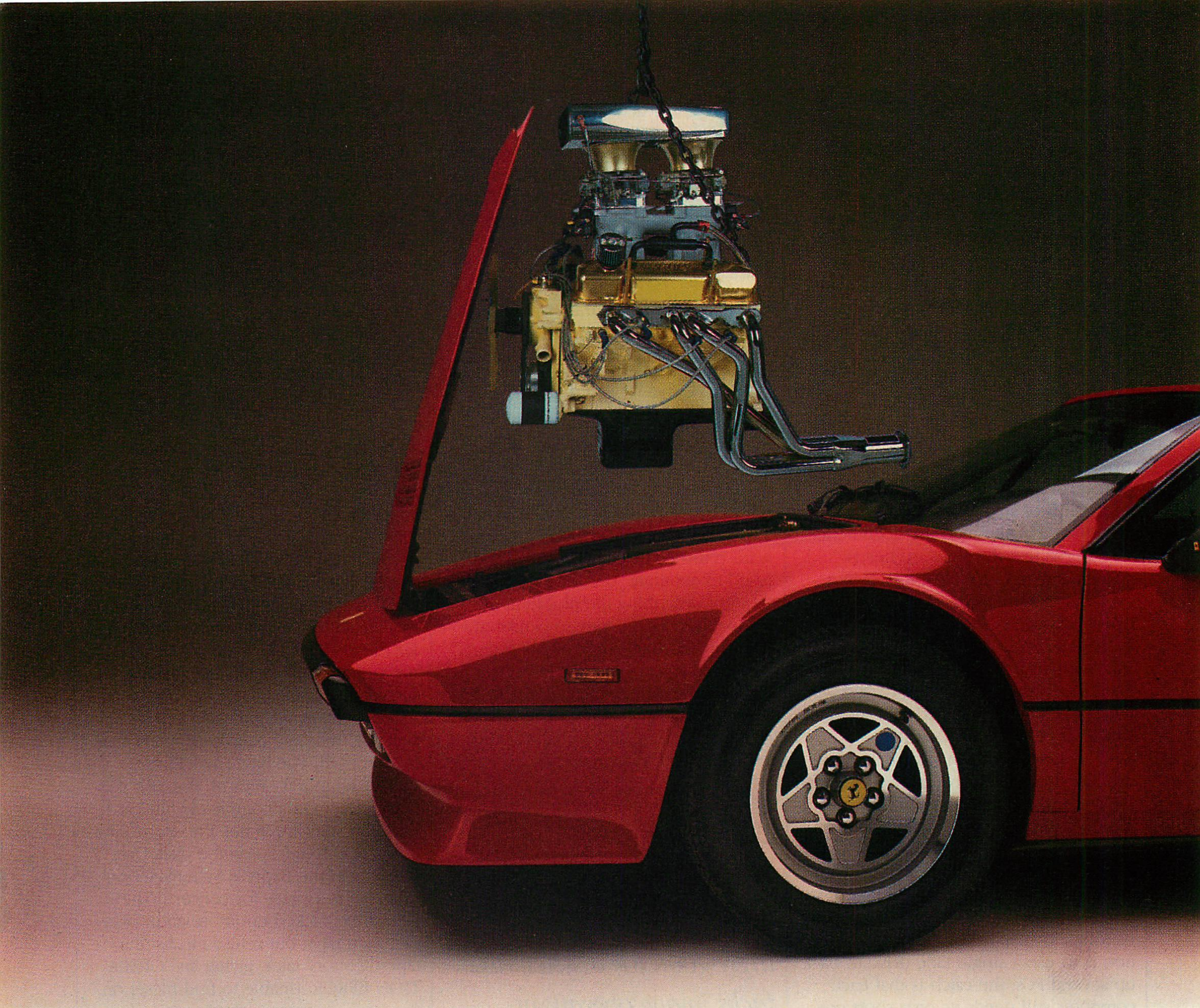
The Express Systems/Orion tape unit has the same backup problem that Sysgen's QIC-File has. The software creates temporary files on the disk it is backing up. On a completely full hard disk, the software is not able to run until space is freed up on the disk. Data integrity in the Express Systems/Orion unit also is a cause for concern. The tape drive backed up information on a damaged tape, but refused to list the tape directory later, giving an "OPERATION ERROR: Unable to find fileset on the tape" message instead.

Documentation for this tape drive is accurate and provides the information needed to run the system. However, installation information specific to the external drive is missing. The high-density, non-typeset text makes information difficult to locate.

Everex Excel. Although the Excel tape unit does not offer some of the backup and restore options of other systems, it allows a file-by-file restore of an image backup. Because the image backup is so fast, most of the missing options are unnecessary with this tape drive.

Excel's external cabinet is like many of the others—a sturdy PC-styled unit that would make a handsome addition to any computer system.

Hardware installation follows the usual process, and it proceeds smoothly except that the cable connector seems especially hard to plug into the controller card. The result in this case was a bent pin. Software installation involves copying files and making modifications



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to the CONFIG.SYS file. No batch file is provided to automate this process.

The tape software was of the menu variety, with function keys used to select options. An exceptional feature of this software is its ability to restore individual files from a tape created using an image backup. Because an image backup takes only 2½ minutes, a complete backup can be made every day with the assurance that a single file can be restored if necessary. With this capability, the provided file-by-file backup operation is unnecessary.

Two other software features are excellent additions to this tape drive: the PROFILE and SCAN operations. PROFILE determines the characteristics of the user's hard disk drive and lists them in a file. Whenever the tape software runs, it looks in the PROFILE file and uses the information there to fine-tune its performance to match the capabilities of the disk. This allows for longer periods of tape streaming (and thus faster operation). SCAN generates a bad sector map of the hard disk and stores it in a file. The tape software examines this file and avoids the bad sectors. By running the SCAN program on two different disks, a user can do an image backup from one disk and an image restore to another and know that the bad sectors on both disks will be avoided. This is a feature that all tape backup software packages should employ.

The Everex software can lead to confusion. Unlike most tape systems, Excel has three separate restore operations: image restore from an image backup, file-by-file restore from a file-by-file backup, and file-by-file restore from an image backup. Users must be especially careful to use the file-by-file restore operation that matches the way the backup tape was created. Using the wrong restore program will result in cryptic error messages that are not explained in the manual.

Another problem that could limit Excel's effectiveness involves a file-by-file restore from an image backup. Attempts to perform this operation aborted with the message "Cannot generate system file (00,03,00)." Only after 100KB were freed on the hard disk would the operation work.

The documentation is helpful, especially in describing the DMA channel and interrupt settings. Although the manual describes what the jumper settings are for these features, it does not provide a clear description of how to change the settings or whether the software could handle those changes. This manual will never win any awards for clarity; it is confusing because it documents three tape drives in a single book and because it does not clearly separate the two different file-by-file restore operations (they are in separate sections, but it's easy to go to the wrong page). In addition, no error message descriptions are included.

Mountain FileSafe. The Mountain tape drive has many interesting features, but it loses points in its evaluation for being loaded with software bugs. It refused to work with the test computer, giving a "Memory Allocation Error" message. Only when the system was moved to another PC (with a 20MB Microscience drive and a Western Digital controller), was it able to back up and restore files. Therefore, the drive was tested on this second computer, using the same amount of memory (320KB), the same amount of data on the hard disk (10,559,488 bytes), and a similar number of files (16 directories and 811 user files). Discrepancies in the test results might exist, however, because of the different controllers and disk drives.

The Mountain tape drive has many interesting features, but it loses points in its evaluation for being loaded with software bugs.

The tape drive comes in a rectangular cabinet with a slightly larger footprint than the usual external expansion box (but not as big as the adic cabinet). Like most of the systems tested, the cabinet is attractive and well-made.

Both hardware and software installation are simple. Handy finger-turn screws on the cable made attaching and removing the cable especially easy. Software installation was merely a matter of copying files to a directory.

The tape software offers both menu and command interfaces. Unlike most other tape drives, FileSafe supports only an image backup option (actually, this option backs up only DOS partitions). But from this image backup, both image restore and file-by-file restore can occur. With FileSafe's speedy image backup and the flexibility of file-by-file restore, no sophisticated file-by-file backup options are needed.

The menu software has several obvious and annoying bugs. First, unless the user specifies otherwise in an option menu, the software always rewinds the tape after performing a backup or restore operation. While the rewind is proceeding, the program allows users to choose options from the standard menus, but when this was attempted during testing, the software tried to read from drive A: (where the program was invoked) and ceased to work, leaving the drive light on. The machine had to be turned off and rebooted.

Another bug occurred when the backup options menu was used to set the verify option (so that tape verification would occur immediately after backup). Instead of returning to the main menu, the software kept presenting the options menu, over and over, until Ctrl-Break was pressed. Later, the same menu worked fine.

Yet another bug appeared during a file-by-file restore. The process should involve typing the path names of the files to be restored and pressing Enter. After the last path name, the user should press Enter again to start the process. In fact, after entering one path name, Enter had to be pressed 11 times before the restore process would begin. Sometimes banging angrily on the keyboard really does work.

For the most part, the manual is organized and accurate, but it does contain some mistakes. In the description of file-by-file restore, for example, it states that restoring the entire hard disk involves typing the following:

```
c:\ /s
```

When those characters were entered, the software could find no files to restore. Adding the characters *.* after the back slash made the procedure work.

Mountain seems to have released its tape drive ahead of its time. So many obvious bugs lying on the surface of the software subtracts from the overall credibility of the system.

Alloy PC-QICTAPE. This is one of the most expensive tape drives of those tested, but its performance does not measure up to other, much cheaper units. The system itself is attractive and well-built, with a full-length, half-width cabinet that mimics the PC's styling.

Hardware installation involves inserting a short controller card and connecting the drive. The manual is helpful here because it discusses how to change port addresses and DMA channels. Software installation is just a matter of copying files from the supplied diskette. This is fortunate, because the documentation offers no description of the process. The hardware instructions

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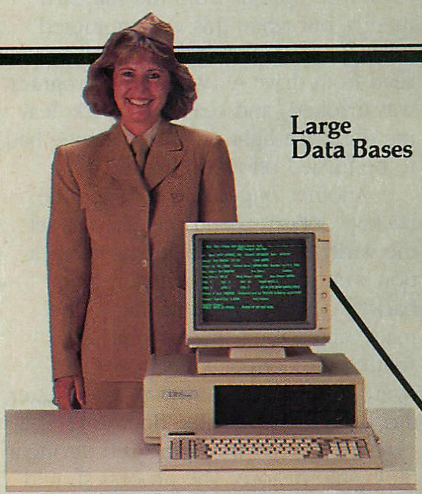

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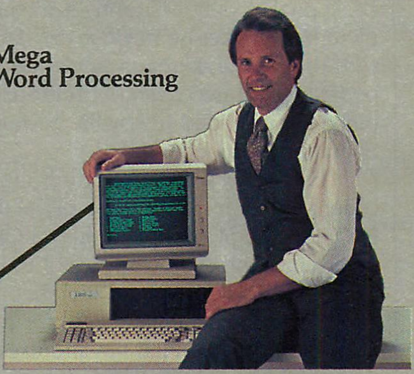

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refer the user to a nonexistent section for this material.

The software provided with Alloy's PC-QICTAPE is menu-driven only, but it does provide a special AUTOTIP file for batch file support. No image backup and restore capabilities are available, and the file-by-file operations are just slow enough to be irritating. A PATCH command allows users to customize the software to their hardware configurations. In addition, Alloy supplies a TUTIL.ASM interface that allows C programs to access tape functions.

One bug discovered in the software caused several hours of frustration. When the CONFIG.SYS file is set up so that BUFFERS equals more than 7, the Alloy software generates a stack overflow message whenever it runs. The message is not described in the manual, so locating the error was a lengthy trial-and-error process. After setting the number of buffers to 7, the software worked correctly. Keep in mind when examining the performance data that this tape drive was tested with BUFFERS=7 instead of 20, the setting used for the other systems.

The PC-QICTAPE documentation is attractive, with its own binder and slipcase. It lacks software installation instructions and descriptions of some error messages, but its hardware installation instructions and its description of the software are effective. Alloy also provides an excellent on-line help facility.

Data Technology TeamMate T60. The TeamMate promises a lot that it cannot deliver, primarily in terms of software. It claims to perform both image and file-by-file backups and to restore individual files from an image backup. Unfortunately, the image backup operation does not seem to work.

Installation of TeamMate T60, as with most of the tape backup systems, was simply a matter of inserting a short controller card, connecting a cable, and copying software from the supplied diskette to a directory.

The documentation, like the software, does not appear to be ready for general release. The copy received for evaluation was touched up with white-out and pieces of paper pasted over offending or inaccurate text. In additon, although the menu software is described, none of the commands is mentioned in the manual. The only information about the tape commands appears in the on-line help.

The TeamMate T60 appears to be a rush job. The hardware might be working, but the software and the manual need to go back for a second draft.

THE SOFTWARE DIFFERENCE

During testing the tape backup systems for this article, one hard disk was backed up and restored at least 60 times. Except for the date and time stamps, the data finally restored to disk were identical to the original data. In the early days of computing, engineers working on the UNIVAC I computer spent months and months trying to achieve the same result when performing successive reads and writes to just 10 of their large UNISERVO mag tape drives. Results such as those achieved with the tape drives tested here would have seemed impossible then.

The major differences among the systems involves software. Only about a half-dozen different physical tape drives are used in all tape systems. There are three or four different interfaces and tape formats. These are relatively minor differences compared to the user software. The highest rated systems had software that was easy to use, reliable, and filled with useful features. The lowest rated systems came with software that in some cases was unusable.

Steven Armbrust is a freelance technical writer. Ted Forgeron is a microcomputer software consultant. They work primarily in the Silicon Forest near Portland, Oregon.

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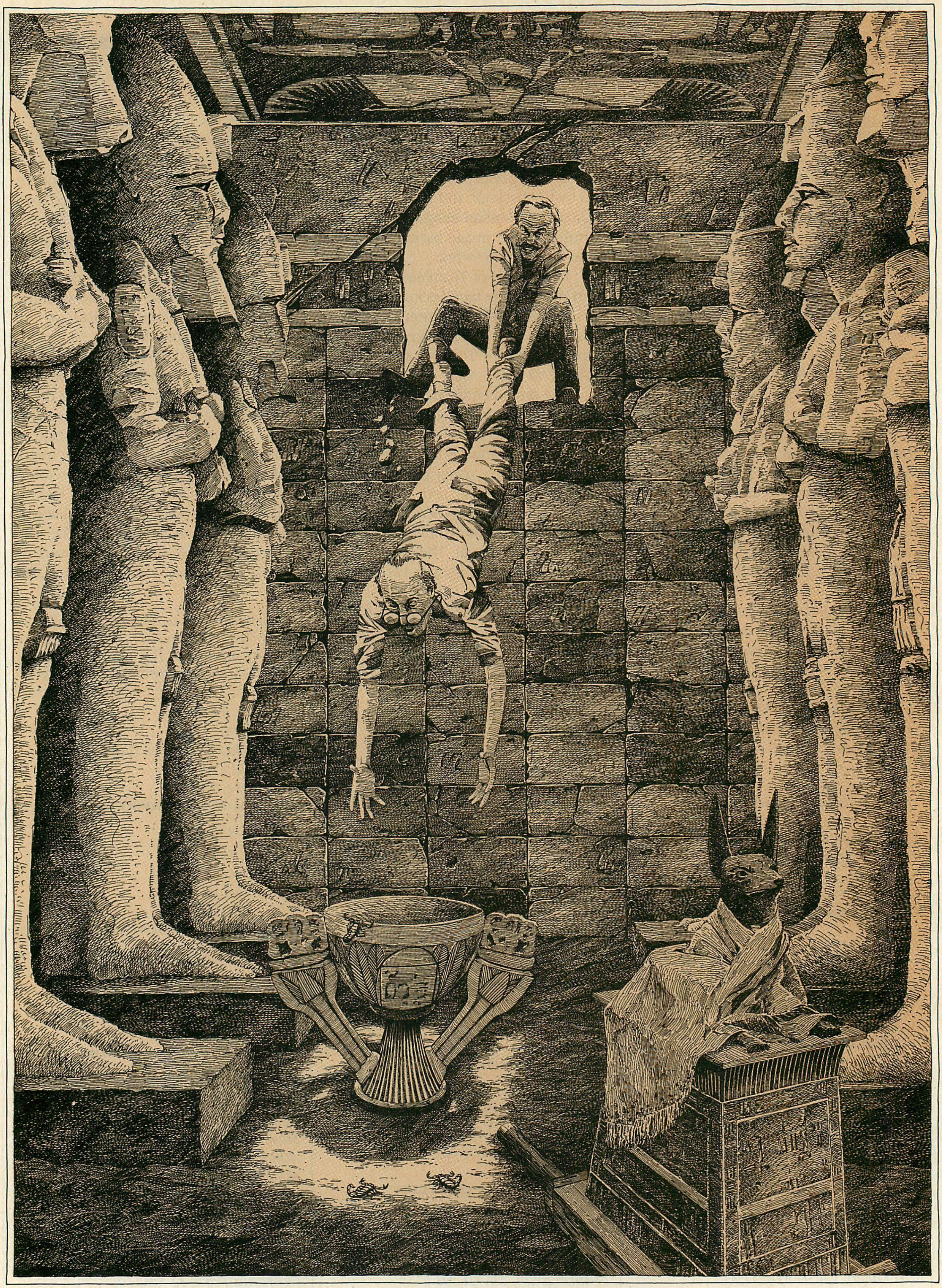

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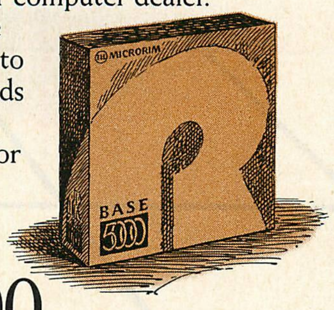

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IBM's AT/370 can be a PC/AT, a dumb terminal connected to a mainframe, or an independent workstation that is compatible with the standard System/370 mainframe.

Desktop Mainframe

By its very nature, the mainframe environment often gives rise to conflict among the many users who must share limited resources. The throughput of the machine is highly dependent on how many jobs are running at any given time. Downtime is always unexpected and usually interferes with development schedules. Frustration can build quickly. The solution that IBM is offering its 370-family mainframe users is a totally compatible mainframe-on-a-desk, called the AT/370.

The AT/370 allows a user to develop or maintain programs with total independence from the mainframe. When the programs are complete, they can be uploaded and run without modification. Additionally, IBM has designed the machine to integrate into the mainframe environment. The file servers supplied by IBM turn the mainframe disk into a transparent extension to the local disk. When executing a program, the AT/370 automatically will determine whether the program resides on the local or the remote disk and will then load it from the appropriate place.

The AT/370 is actually an enhanced model PC/AT with two options installed: the 370 option emulates the System/370 instruction set; the 3278/79 emulation board is responsible for all mainframe communications, allowing for a direct connection to a standard IBM 3274 communications controller.

With this additional hardware the AT/370 can operate in three modes: as a standard AT with 640KB of memory addressable under PC-DOS; as a dumb terminal in an IBM mainframe environment; or as a PC/370, a totally independent workstation capable of executing programs in an environment compatible with a standard IBM 370 mainframe

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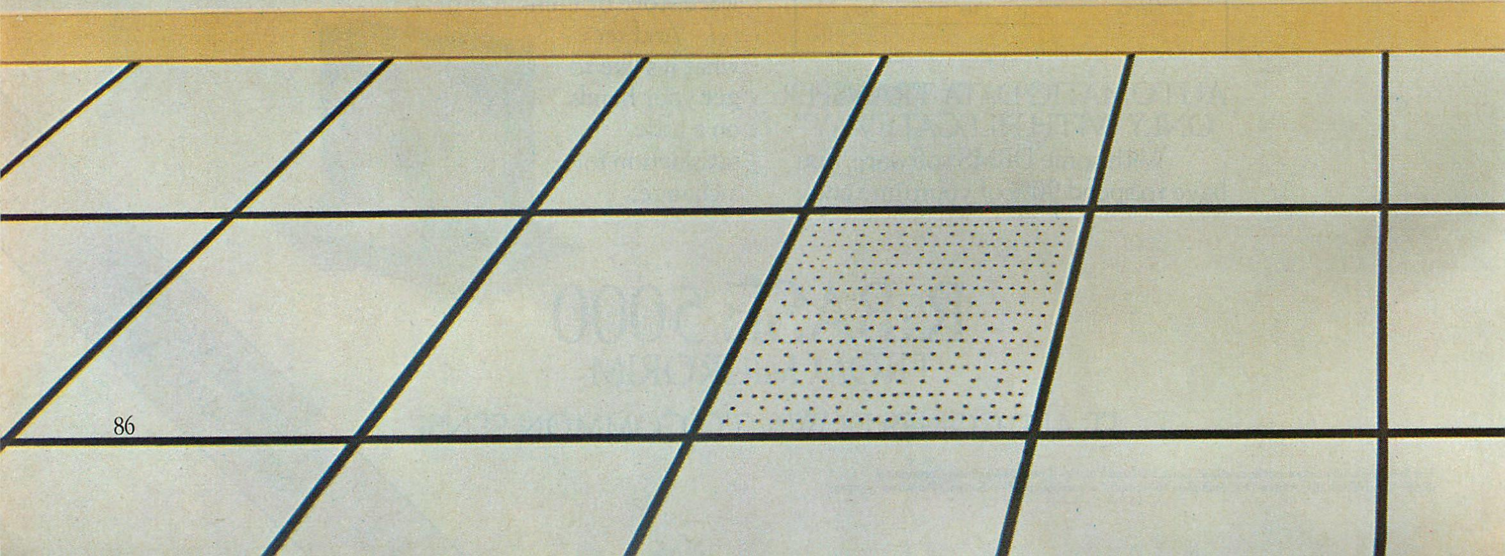
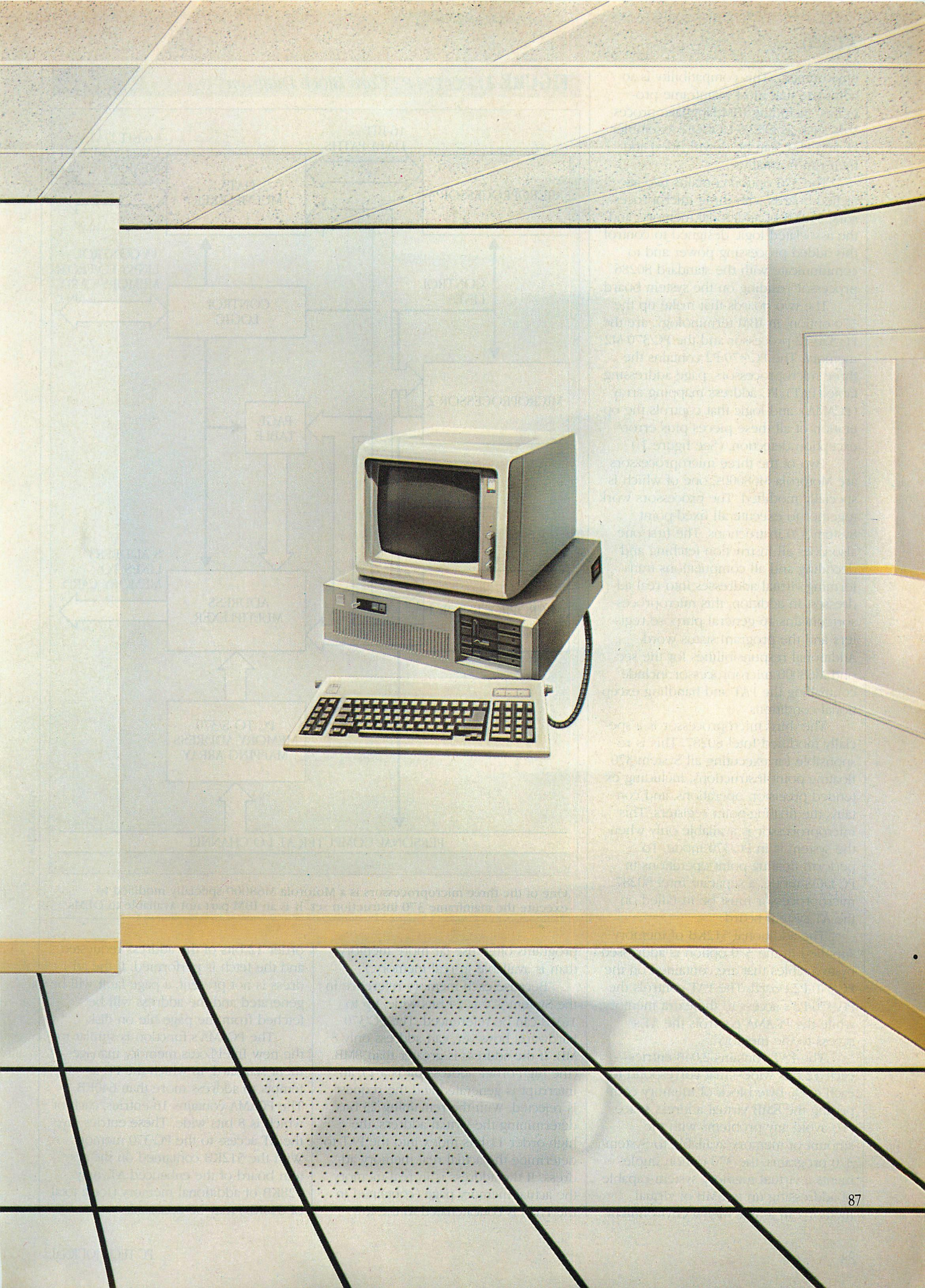
STEVEN GREENFIELD and ALAN PENDLETON





environment. This compatibility is so complete that most mainframe programs, including IBM language processors such as OS/VS COBOL, Assembler H, and PL/1, can be downloaded and then run normally.

The 370 option contains two attached boards with three microprocessors, 512KB of additional memory, and the associated logic designed to control this added processing power and to communicate with the standard 80286 processor residing on the system board.

The two boards that make up the 370 option, in IBM terminology, are the PC/370-P2 processor and the PC/370-M2 memory. The PC/370-P2 contains the three microprocessors, page addressing table (PAT), PC address mapping array (PCAMA), and logic that controls the operation of all these pieces plus error/exception detection. (See figure 1.)

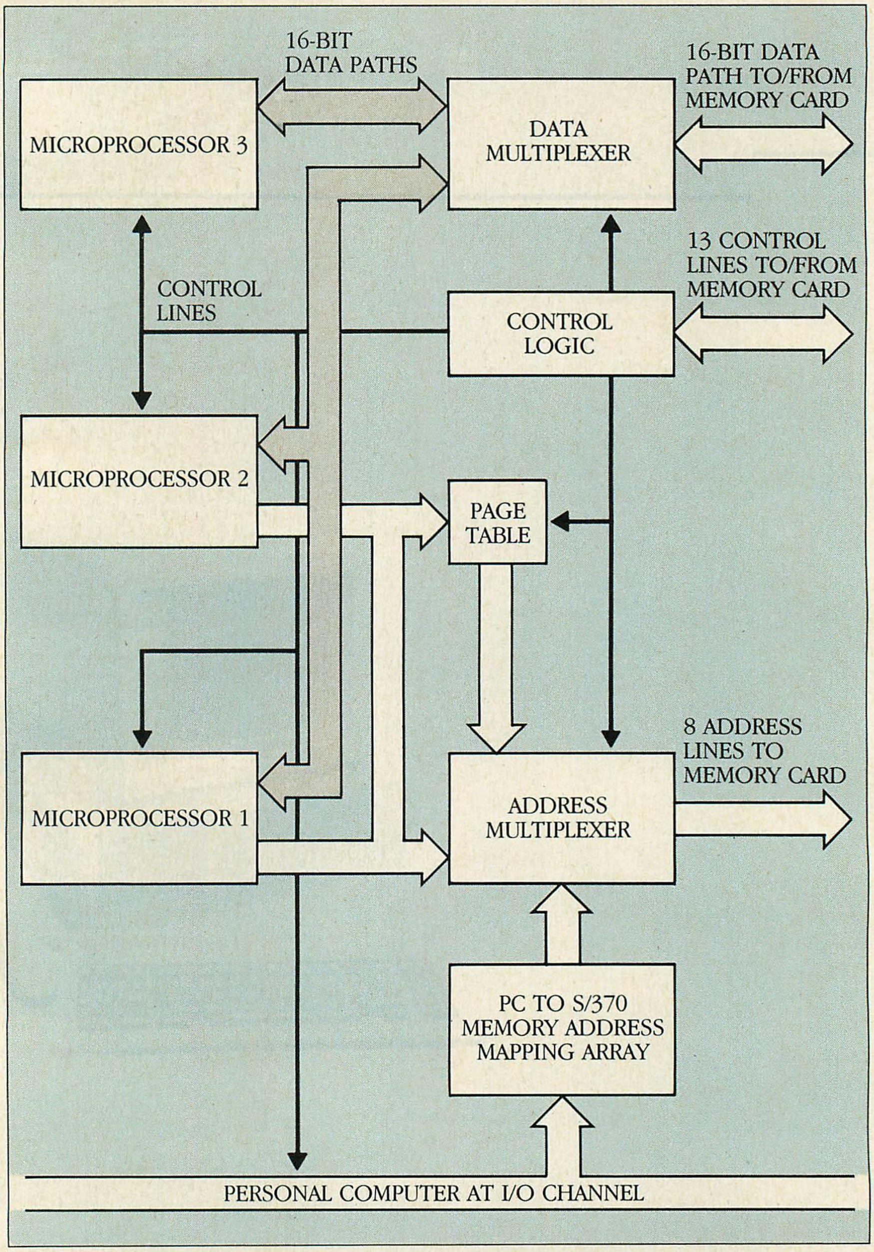
Two of the three microprocessors are Motorola M68000s, one of which is specially modified. The processors work together to execute all fixed-point System/370 instructions. The first one also does all instruction fetching and decoding and all computations transforming virtual addresses into real addresses. In addition, this microprocessor contains 16 general purpose registers and the program status word. Additional responsibilities for the second M68000 microprocessor include controlling the PAT and handling exceptional conditions.

The third microprocessor is a specially modified Intel 80287. This is responsible for executing all System/370 floating-point instructions, including extended precision operations, and contains the floating-point registers. This microprocessor is available only when the system is in PC/370 mode. To perform floating-point operations in PC-DOS mode, a separate Intel 80287 microprocessor must be installed on the AT system board.

The additional 512KB of memory supplied in the 370 option is addressed by two tables that are contained on the PC/370-P2 board. The PAT controls the PC/370-P2's access to the extra memory, while the PCAMA controls the AT's access to the memory.

The PAT contains 2,048 entries—each 12 bits wide—that correspond to each 4,096-byte block of memory comprising the 8MB virtual address space. (To avoid any problems with the amount of memory available to System/370 programs, the 370 option implements a virtual memory system capable of addressing up to 8MB of virtual memory. In a System/370 environment,

FIGURE 1: *PC/370-P2 Card Block Diagram*



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One of the three microprocessors is a Motorola M68000 specially modified to execute the mainframe 370 instruction set. It is an IBM part not available to OEMs.

programs often use far more memory than is available in real memory.)

Because each memory reference in the System/370 is 24 bits wide, up to 16MB can be referenced. The PC/370 hardware, however, can address only 8 MB. If the address is greater than 8MB (the high-order address bit is a 1), an interrupt is generated and the request is rejected. With the remaining 23 bits determining the virtual address, the high-order 11 bits index into the PAT to determine the actual real memory address. If the address is in real memory, the actual memory page (contained in the PAT) is concatenated to the low-order 12 bits of the address requested and the fetch is performed. If the address is not present, a page fault will be generated and the address will be fetched from the page file on disk.

The PCAMA's function is similar to the new Intel/Lotus memory management standard, in which the PC attempts to address more than 640KB. The PCAMA contains 16 entries, each of which is 8 bits wide. These entries give the AT access to the PC/370 memory. With the 512KB contained on the system board of the enhanced AT, only 128KB of additional memory (for a total of 640KB) may be accessed.

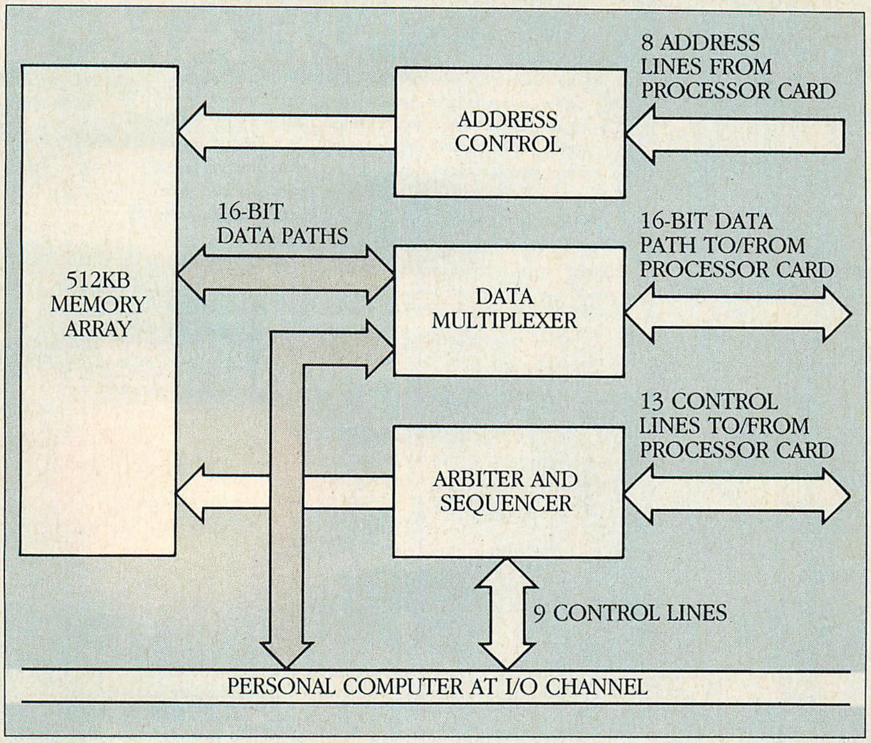
Each of the 16 entries in the PCAMA contains an address of an 8,192-byte block of memory in the PC/370 memory. By changing the PCAMA entries, the AT may access all 512KB of additional memory. Unfortunately, the PCAMA is active only when operating in PC/370 mode. When operating in PC-DOS mode, only the first 128KB of additional memory is accessible.

The PC/370-M2 memory board contains 512KB of memory, which is made up of the same 128K-bit piggyback memory chips used on the system board. (See figure 2.) In fact, this memory is organized in the same four rows of nine chips to make up the complete 512KB of parity-checked memory. When the system is operating in the PC/370 mode, this memory is addressed by the PC/370-P2 board in two overlapping ranges. The first range, spanning 480KB, is used for program storage and execution. The second range of 32KB is used for control storage containing microcode; it occupies the remaining physical RAM on the PC/370-P2 board. Addressing of both areas begins at 0, even though one range is physically higher than the other one.

The 80286 processor contained on the system board may reference the memory in one of two ways. If the 80286 is operating in a support role for the PC/370-P2 board, all 512KB on the PC/370-M2 board may be accessed in 128KB increments. If the 80286 is operating under control of DOS, only the first 128KB may be accessed.

Because both the PC/370-P2 board and the 80286 processor may access the PC/370-M2's 512KB simultaneously, the M2 board contains logic to arbitrate these memory requests. It places the most recent user of this memory on a lower priority. Thus, the two processors are forced to take turns accessing memory, and an equitable sharing of memory is guaranteed because neither processor will be locked out for more than one memory request time. Arbitration time is added to the memory accesses even in PC-DOS mode, so references to the additional 128KB residing on the PC/370-M2 will be one clock cycle slower than if the AT's 128KB memory upgrade were installed.

FIGURE 2: *PC/370-M2 Card Block Diagram*



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Physically, the 512KB RAM on the PC/370-M2 memory board is identical to the RAM on the PC/AT motherboard, including the 128KB piggyback modules.

3278/79 EMULATION ADAPTER

The 3278/79 emulation adapter provides the ability to link the AT/370 to an IBM mainframe through the standard display terminal interface. It is capable of supporting the following connections through a coaxial attachment using an A-type adapter: 3274 controller; 4321, 4331, or 4361 processor through the display printer adapter; 4361 processor through the workstation adapter; 4701 finance communications controller through the device cluster adapter.

The 3278/79 emulation adapter can emulate a 3278 model 2 display station when the AT/370 is configured with a monochrome display. With a color display, the adapter provides 3279 model 2A or model S2A emulation with default 3279 base color emulation.

The AT/370 is generally hardware-compatible with most AT option boards, although the software to operate many option boards in PC/370 mode may not be available. For example, the only method of 3278/79 emulation available while the system is running as a PC/370 is the IBM 3278/79 emulation adapter through to an approved IBM mainframe connection, even though a more suitable connection might be preferred.

Because an AT/370 comes with a display adapter, a serial/parallel adapter, and a disk controller, in addition to the 370 option and 3278/79 emulation adapter, only two slots remain for other adapters. Additional memory installed in these slots must start addressing above the 1MB line. The AT/370 supports virtual disks and, under DOS, provides the expected performance improvements. In PC/370 mode, however, performance suffers a degradation of nearly 30 percent because the PC/370 method of memory manipulation is incompatible with VDISK.

Implementation of the System/370 in PC/370 mode is good. The deviations between the PC/370 and IBM's 370 mainframe are in the following areas:

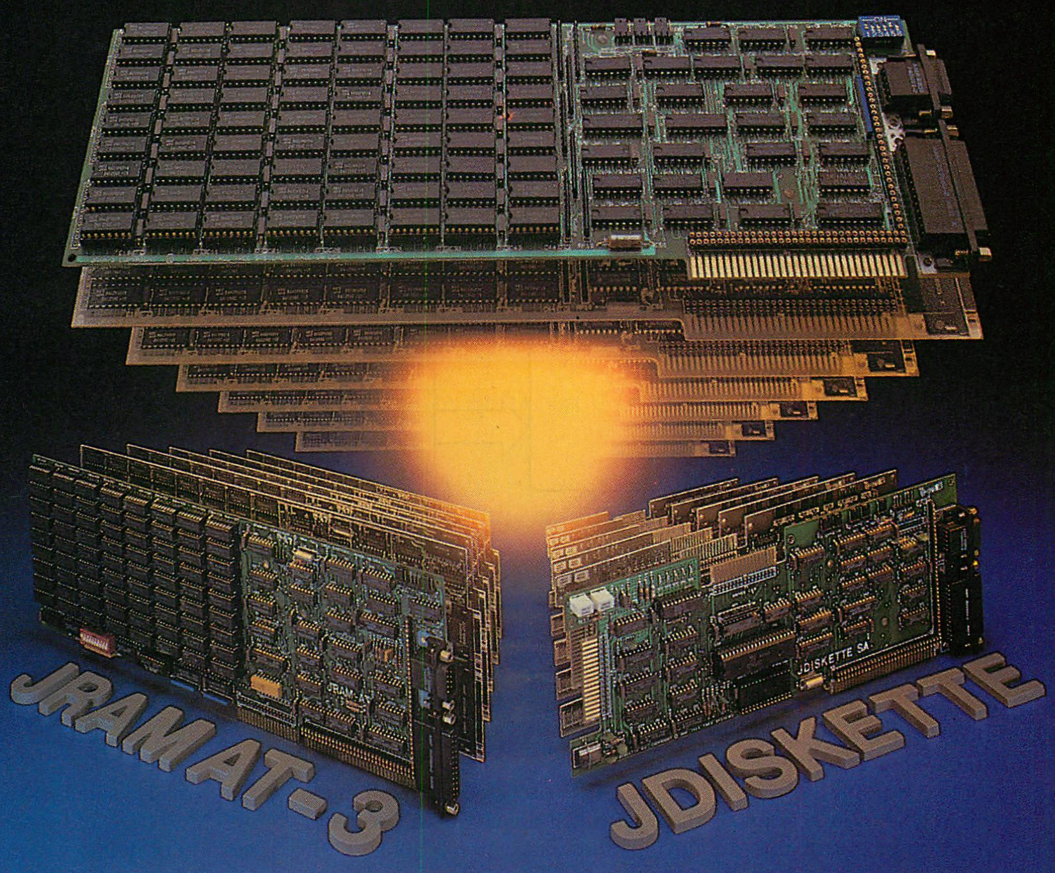
Storage keys. The AT/370 does not support storage keys. When a storage key is read, it is always returned as 0. The set-storage-key instruction may be used, but, regardless of the value, the next read will always return a 0.

Timer instructions. The timer used on the AT/370 is the same as the one used by DOS and may be set under PC-DOS mode. This timer is accurate to the nearest 65 milliseconds, which is far less than the standard System/370 timer. Additionally, the System/370 interval timer is not supported; the set-clock instruction is ignored.

I/O and channel instructions. This area is quite different from the standard System/370. The interface to I/O devices on the AT/370 is through the diagnose instruction, which requests DOS to perform the I/O. When I/O is complete, DOS returns to PC/370 mode with the resulting simulated condition code.

Translation instructions. The AT/370 implements dynamic adddress translation somewhat differently than in the

THE FAMILY TREE



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System/370. Specifically, a page addressing table is used instead of segment and page tables. This difference limits virtual memory to 8MB rather than the standard 16MB. It also requires some differences in the method of operation for some of the translation instructions.

AT/370 SOFTWARE

The operating system that drives the AT/370 hardware is VM/PC (Virtual Machine/Personal Computer). It is compatible with the mainframe operating system VM/SP, release 3, in all except a few details. VM/PC provides the AT/370 user with a CMS (Conversational Monitor System) environment that looks identical to the CMS on mainframes.

The faithfulness of the reproduction of CMS on the AT/370 allows any well-behaved program to be downloaded in object-code form from a mainframe to an AT/370 and run successfully; recompilation is not necessary. *Well-behaved* means that the program limits itself to documented CMS calls for operating-system services and does not depend on the particular format of CMS internal structures. For example, the compilers that run in 370 mode on the AT/370—including COBOL, Pascal, FORTRAN, and BASIC—are byte-for-byte the same as the mainframe CMS versions of IBM's compilers. In fact, they are available only as mainframe products and must be downloaded to the AT/370.

VM/PC supports four processing modes and has limited multi-processing capability; it allows that sessions in more than one processing mode may be in progress concurrently. The four processing modes are:

Local session. The AT/370 executes code on its own processor emulating the 370 instruction set. Most CP and CMS commands are supported.

Remote 3278/79 session. The machine acts as a 3278 (monochrome monitor) or a 3279 (color monitor) terminal connected to a mainframe through the 3278/79 emulation adapter.

Remote 3101 session. The machine acts as a 3101 terminal over an RS-232 interface through the serial/parallel adapter.

370 processor control. This mode provides a simulated front panel by which the registers and storage of a local session may be examined and modified.

One of each of the three session types may be in progress at any one time, and the 370 processor control mode is available at all times. For example, a series of compilations can begin in the local session, and while these are still executing the user can switch to the remote session, log on the host mainframe, and work on that machine. The Sys Req key is used to move between the sessions; pressing it calls up a menu showing the four choices.

If screen activity occurs in one of the sessions not currently displayed, an indicator appears on the status line. VM/PC provides an easy means to upload and download files to and from a mainframe running CMS or TSO.

The AT/370 can act as a terminal of a host computer using the 3270 coaxial connection on the back of the 3278/79 emulation adapter. Remote-session capability is available only on AT/370 systems with the 3278/79 adapter installed. When in remote-session mode, the user can connect with VM, CICS, IMS, TSO, or MVS systems, or any host that supports 3278 model 2 data streams. The remote session can be used in conjunction with the local session to provide file-transfer capability.

The faithfulness of the reproduction of CMS on the AT/370 allows any well-behaved program to be downloaded in object-code form from mainframe to AT/370 and run successfully.

The AT/370 also can emulate a 3101 display terminal from within the VM/PC environment. The IBM 3101 Emulation Program must be installed on the machine in order to run a remote 3101 session, which can be used to transfer DOS ASCII files between the AT/370 and the host computer.

When a local session is in progress, the AT/370 is a self-contained CMS workstation; it becomes the long-awaited "370 on a desktop." It is able to duplicate most of CMS's capabilities as well as some of its idiosyncrasies.

The original concept behind CMS, developed before the era of microcomputers, was to give each user a virtual machine, or the illusion that each user had a complete machine to himself. A control program called CP takes care of simulating each user's virtual machine. CMS runs as an operating system on top of CP. A CMS user can halt execution and look at registers and storage. Although this is no longer a novel concept, at the time CMS was developed it was quite a noticeable improvement over the take-storage-dump/print-dump/pore-over-dump method of debugging that was then in vogue.

Seasoned microcomputer users will bemoan CMS's lack of sophisticated screen handling. This is unavoidable, however, because CMS must maintain compatibility with the way mainframes interact with their terminals: either in line-at-a-time Teletype mode or in full-screen mode. In full-screen mode data are sent to the terminal in a block called a *data stream*, and the minimally intelligent, 3270-type terminal processes user keystrokes and returns a data stream to the computer whenever the user presses a control or a function key. The AT/370 uses the same keyboard as the standard AT, with certain keys redefined as 3270 keys when VM/PC is in operation. For example, the Esc key is redefined as Clear, Backspace becomes New Line, and End is Erase EOF. PF1 through PF12 are obtained using F1 through F10, Shift-F1, and Shift-F2. The program attention keys, PA1 through PA3, are obtained using the Alt key with F1 through F3.

CMS MINIDISKS

In addition to having a virtual machine, each CMS user also has one or more virtual disks called *minidisks*. These are preallocated blocks of disk storage that simulate a physical disk. VM/PC maintains CMS minidisks on PC disks, either hard or floppy. The size of each minidisk must be specified at configuration time, and the entire minidisk is then allocated as a DOS file. Space within the minidisk is allocated to user files as they are created.

CMS files are specified with a three-part file identifier. The first part is an eight-character file name. The second part is an eight-character file type, similar to the three-character file-name extension used by DOS in that some file types have pre-defined meanings. For example, executable code must have the file type MODULE, and input to the COBOL compiler must have the type COBOL. The third part of the file identifier is a two-character file mode. The first character of the file mode is a letter indicating on which minidisk the file is located. A file-mode letter is associated with a physical minidisk via the ACCESS command. The second character is either a blank or a digit from 0 to 6 indicating certain file characteristics.

A file in CMS format on a minidisk can be created from a DOS file using

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TABLE 1: *CP and CMS Commands Supported*

CMS COMMANDS SUPPORTED

LIBRARY COMMANDS					
ACCESS	FORMAT	RELEASE	RESERVE		
FILE COMMANDS					
COMPARE	COPYFILE	ERASE	EXPORT	IMPORT	RENAME
FILE MANIPULATION					
CMDCALL	FILEDEF	LISTFILE	MACLIB	PRINT	SORT
TXTLIB	TYPE	UPDATE	XEDIT		
STACK MANIPULATION					
DESBUF	DROPBUF	IDENTITY	MAKEBUF	SENTRIES	
EXEC SUPPORT					
EXEC	EXECIO	GLOBALV	REXX		
NUCLEUS EXTENSION SUPPORT					
NUCXDROP	NUCXLOAD	NUCXMAP			
LOADER SUPPORT					
GENMOD	LOAD	LOADMOD	MODMAP		
ENVIRONMENT CONTROL COMMANDS					
QUERY	SET	SYNONYM			
XEDIT APPLICATIONS					
DEFAULTS	FILELIST				

CMS COMMANDS NOT SUPPORTED

AMSERVE	ASSEMBLE	ASSGN	CMSBATCH	DDR	DISK
DLBL	DOSLIB	DOSLKED	DSERV	EDIT	ESERV
FETCH	NAMEFIND	NOTE	OPTION	OSRUN	PEEK
PSERV	PUNCH	RDR	RDRLIST	READCARD	RECEIVE
RSERV	RUN	SENDFILE	SETPRT	SSERV	SVCTRACE
TAPE	TAPEMAC	TAPPDS	TELL		

CP COMMANDS SUPPORTED

#CP	ATTN	BEGIN	CHANGE	CLOSE	CP
DEFINE	DETACH	DISPLAY	DUMP	EXTERNAL	IPL
LINK	LOGOFF	ORDER	PURGE	QUERY	REQUEST
SET	SPOOL	STORE	TAG	TERMINAL	TRACE

Most of the CMS and CP commands that are not supported involve mainframe features connected to specific hardware peripherals not available to the PC/AT.

the IMPORT command or can be used to create a DOS file using the EXPORT command. Normally, an import or export operation converts between the EBCDIC character set used in CMS files and the ASCII character set of DOS files. A NOASCII option is available to bypass the conversion. EXPORT normally adds the standard DOS carriage return/line feed characters at the end of each record, but this too may be bypassed with the NOEOL option.

Data may be transferred between AT/370s in several ways. The easiest method is to define a CMS minidisk on a diskette; VM/PC will treat the diskette as just another minidisk. Files can be copied onto the diskette using the COPYFILE command. The diskette can be moved to any other AT/370 on which the minidisk has been defined with the same name and size. Defining a minidisk on a diskette limits its size to that of the diskette, however. To transfer files larger than the size of a diskette, the DOS BACKUP command can be used to back up a minidisk onto as many diskettes as are required; then the DOS RESTORE command can restore the minidisk onto another system.

Users with access to a host mainframe can upload files from one AT/370 and download them to another. To perform file transfers to and from a CMS host, the user executes the VM/PC file server program VMPCSERV on the host from the remote session. VMPCSERV than handles the host end of file transfers and information requests. From the AT/370 user's point of view, once a connection is established, CMS minidisks on the host are treated as though they are local. Files on the host can be read and written. They can even be executed locally. The only difference is the slower response time caused by the need to transfer data across the link to the host.

VMPCSERV, included as part of VM/PC, also provides the ability to spool print files to the host printer. To perform file transfers to and from a TSO host, an analogous program called TSOSERV is available separately. Like the VMPCSERV program, TSOSERV is executed on the host from the remote session. It provides the ability to read and write MVS sequential and partitioned data sets on the host from the local session; in addition, it allows some TSO commands to be executed on the host from the local session and to spool print files to the host printer.

TSOSERV provides a means for mapping CMS file names onto MVS file names. To access an MVS file, the user first describes the mapping, then references the file with the equivalent CMS file name. For example, if a TSO user ID has been associated with the file mode R (by invoking the CP LINK and CMS ACCESS commands), the mapping

DSNMAP R SOURCE.&FT.&FN

would specify that the CMS file identifier PGM1 SYS1 R is actually a reference to the MVS file, USERID.-SOURCE.SYS1.PGM1. The mapping

DSNMAP R COPYLIB.&FT(&FN)

would specify that the same CMS file identifier refers to the MVS member userid.COPYLIB.SYS1(PGM1).

A debug facility available for the AT/370 is similar to the front-panel debugging facilities on other 370 processors. It provides the ability to stop and start the processor, execute instructions in single-step mode, reset the processor, and generate an external interrupt to the processor. It also can display and modify in a full-screen format the 370 registers (general purpose, floating point, and control), the program status word, main storage—either real or virtual—and the page address table.

Another function allows the user to set a breakpoint at a particular instruction address. Because the address must be specified as a real, not a virtual, address, this feature is of little value to the applications programmer. It appears to have been created to debug VM/PC. Equivalent functions are available as CP commands (DISPLAY, DUMP, STORE, and TRACE), which provide the AT/370 with powerful debugging capabilities.

Applications that run on mainframe VM/CMS also will run under VM/PC on

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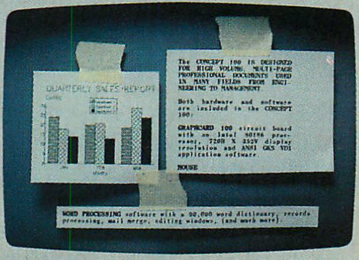

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the AT/370 as long as the following stipulations are met:

- The application must use one virtual address space and must not require a virtual machine larger than 8MB.
- The 3278 model 2 or 3279 model 2A or S2A terminal must be supported.
- The application must not rely on the protection exception, DOS/VSE emulation, VSAM, internal VM/SP structures, tape I/O, virtual readers or punches, or time-dependent operations.
- The application must use only supported commands. Table 1 gives a list of the CP and CMS commands that are supported, along with a list of the CMS commands not supported.

Features present in VM/PC but not in mainframe VM/SP are a relocating loader, the IMPORT and EXPORT commands, and host upload and download functions. The LOAD and GENMOD commands have been extended to allow relocation information to be appended to CMS modules when they are created. This information is used by the NUCXLOAD command whenever the module is loaded into the CMS nucleus extension. This extension was required because the CMS linkage editor LKED is not included with VM/PC.

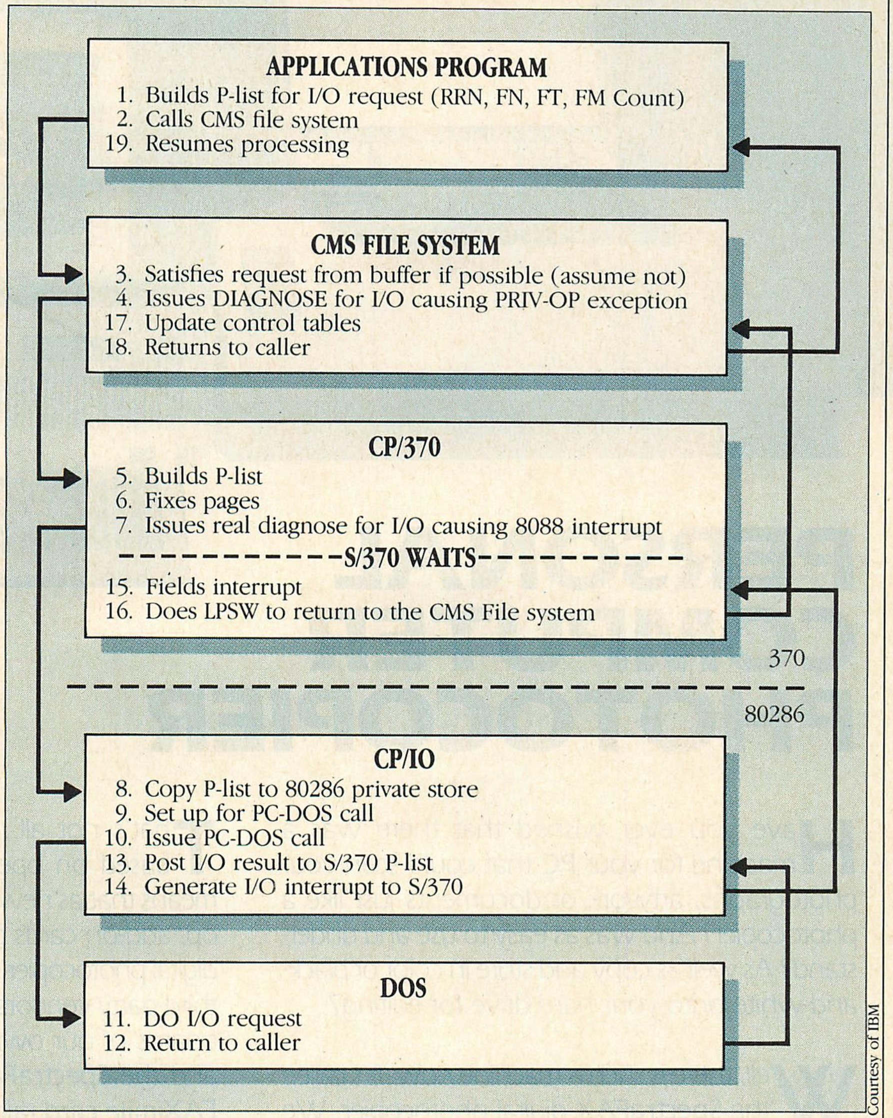
Programming languages for the AT/370 are COBOL, FORTRAN, Pascal VS, BASIC, PL/1, and Assembler H—the same used on mainframe CMS. A compiler that resides on a host can be executed locally on an AT/370, although downloading and executing a compiler from a local minidisk is faster. IBM requires a compiler to be licensed for use on each AT/370 that executes it, regardless of whether the compiler is downloaded to the AT/370's hard disk.

Other software that can be licensed from IBM for use on the AT/370 includes Document Composition Facility (SCRIPT/VS), Interactive Instructional Authoring System (IIAS), Interactive Instructional Presentation System (IIPS), Display Management System (DMS/CMS), Interactive System Productivity Facility (ISPF), CMS Sort, High-Accuracy Arithmetic Subroutine Library (ARITH), and The Information Facility (TIF).

The configurator program VMPCCON is provided with VM/PC. It runs under DOS and allows maintenance of VM/PC's configuration file. This file contains lists of user IDs and passwords and information about each user's minidisks, including the size of the minidisk, on which PC disk drive it is found, and the read/write share passwords that control user access.

The configuration file also determines the size of each user's virtual address space. VM/PC supports virtual memory up to 8MB, but to do so requires 8MB of hard-disk space. Virtual memory therefore should be limited to the amount reasonably required by the application. Only one paging file is maintained on the disk by VM/PC, and its size is changed to match the size of virtual memory required by the currently executing user ID.

FIGURE 3: *I/O Flow within VM/PC*



A worst-case I/O request may be forced to work through five distinct layers, from the VM/PC application all the way down to PC-DOS. Information is passed from layer to layer via a parameter list.

VM/PC consists partially of code that runs on the AT/370's 80286 chip. Called CP/IO, it runs under DOS 3.0 or 3.1 and performs all of the I/O services required by VM/PC—disk, screen, and keyboard. It also handles session management tasks, print spooling, and communication with the host.

The rest of the VM/PC code runs on the machine's 370 chip set. It has two layers, one corresponding to CP and one to CMS. The CP layer handles paging management, privileged operation simulation, diagnose instruction simulation, and the processing of CP commands. The CMS layer runs on top of CP and handles the processing of CMS commands and service calls. The two parts of VM/PC communicate with one another over the I/O channel using interrupts and two pointers that are defined in S/370 control storage. The pointers point to information describing service requests and replies from one processor to the other.

Consider what happens when an applications program issues a disk I/O request. The application builds a parameter list describing the I/O operation to be performed and calls the CMS file

system, which checks its buffers to see if the request can be satisfied without going to the disk. Assuming that it cannot, it issues a diagnose instruction for I/O, causing a privileged operation exception. The exception is processed by CP, which builds a parameter list, fixes the pages of virtual memory to be used, and issues a real diagnose for I/O that causes an 80286 interrupt. The interrupt is handled by CP/IO, which copies the parameter list to its own storage, then sets up and issues a DOS call. DOS performs the physical I/O if the request cannot be satisfied from its buffers. When control returns to CP/IO, it posts the result of the operation to the parameter list and generates an interrupt to the 370 processor. The CP program in the 370 processor, which has been waiting while the 80286 does its work, fields the interrupt. It returns to the CMS file system by executing a Load PSW instruction. The CMS file system updates its control tables and returns to the application. (See figure 3).

The AT's disk drive is much slower than a mainframe's 3380 disk drive, so if page faults occur too frequently, performance can suffer.

PRICE OF CONVENIENCE

The AT/370's 8MB of virtual addressing space is both a blessing and a problem. On the positive side, it allows for the creation of enormous programs without any consideration of the limitations of the AT's native architecture. Programs do not have to be segmented into overlay or chain modules, and data structures are not limited to 64KB.

The price of this convenience is the overhead caused by page faults. Whenever a program requires a piece of data not in real memory, a page fault is generated. The machine has to read in from disk the page of storage containing that piece of data, and it may have to write to disk a page of storage to make room for the page being loaded. The AT's disk drive is much slower than a mainframe's 3380 disk drive, so if page faults occur too frequently, performance can suffer.

Programs with working sets (the virtual memory pages it is using during a given period of time) of 416KB or less probably will not be affected by page faults, because that is approximately the amount of real memory available to applications programs.

The AT/370 performs better if its paging file is allocated in one contiguous block rather than in chunks scattered all over the disk. This decreases the seek time between consecutive accesses to the paging file. If the next release of VM/PC allows the paging file to be placed on a virtual RAM disk, an obstacle to the efficient processing of large programs will be cleared up.

IBM claims the typical compile speeds shown in table 2 for the AT/370 language processors; *PC Tech Journal* received approximately the same results. To test execution speed, three of the benchmark programs used in *PC Tech Journal*'s Pascal compiler review ("Pascal Times Four," Jeff Duntemann and Michael Bentley, July 1984, p. 58) were repeated in table 3. Each benchmark was compiled, linked, and executed on the AT/370 using IBM's Pascal VS. Then, they were run in standard AT mode using Turbo Pascal with 80287 support. Execution speeds are comparable, although Turbo cannot be matched in compilation speed.

TABLE 2: *Compilation Speed*

LANGUAGE PROCESSORS	LINES PER MINUTE
Assembler H	557
BASIC	216
OS/VS COBOL	205
VS FORTRAN	125
Pascal VS	594
PL/1 Optimizing	179

All of these language translators are mainframe products in 370 machine code, downloaded into the AT/370. Note that Pascal VS compiles faster than Assembler H.

TABLE 3: *Execution Speed*

BENCHMARK	AT/370 Pascal VS 2.1	AT Turbo Pascal 3.01A
TRIGTEST		
Compile/link	1:10	0:00.5
Code size (bytes)	41,824	10,371
Code speed per iteration	0:00.17	0:00.15
10 × 10 MATRIX MULTIPLY		
Compile/link	1:15	0:01.4
Code size (bytes)	46,184	11,526
Code speed per iteration	0:00.11	0:00.28
ERATOSTHENES SIEVE		
Compile/link	1:06	0:01.1
Code size (bytes)	40,984	10,425
Code speed per iteration	0:00.68	0:00.58

The power of the 370 instruction set does not necessarily include code speed. File operations (not tested here) can be significantly slower in 370 mode.

Speculation about a microcomputer equivalent of the IBM System/370 has long been a topic of discussion in the mainframe world. The speculation is over. In raw processing speed, the AT/370 is the equal of the 370 model 145, which was in use ten years ago and was powerful enough to handle a network of 700 terminals. The AT/370 exceeds the 370 model 145's real storage of 384KB. In total throughput, the mainframe still holds the edge due to its much faster access to disk storage. However, considering that the AT/370 now can sit on the user's desk and does not have to be shared with 700 other users, the system has certainly come a long way.

Both Steven Greenfield and Alan Pendleton have been working on the AT/370 since it was released. They are helping to develop a product called MicroCICS, which will simulate mainframe CICS on the AT/370. Greenfield is the director of product support and Pendleton is the manager of research and development for Unicorn Systems Company.

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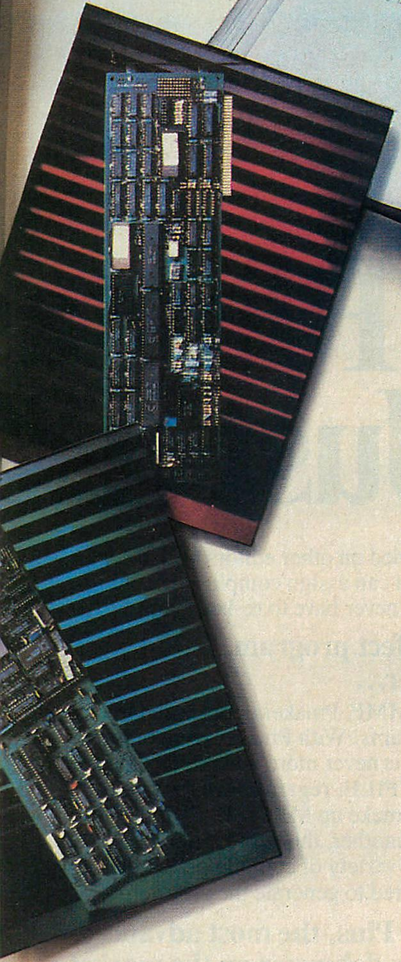

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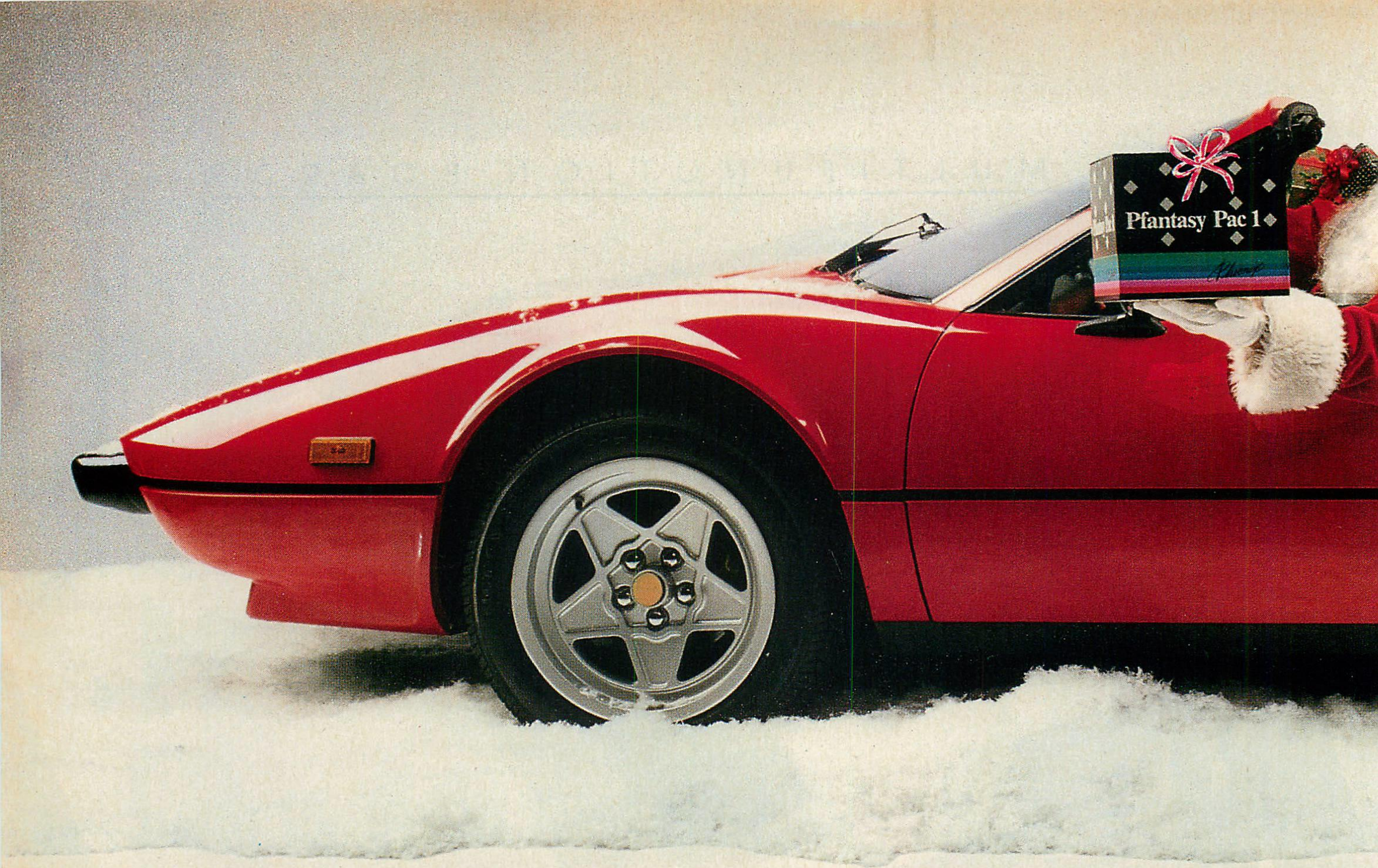

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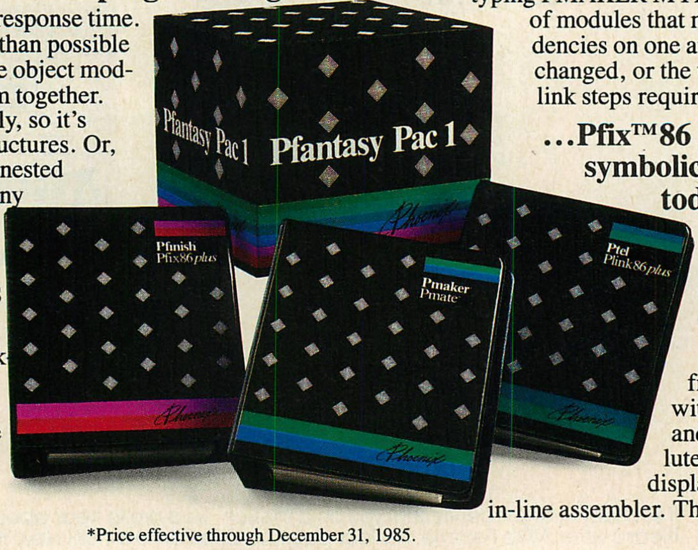

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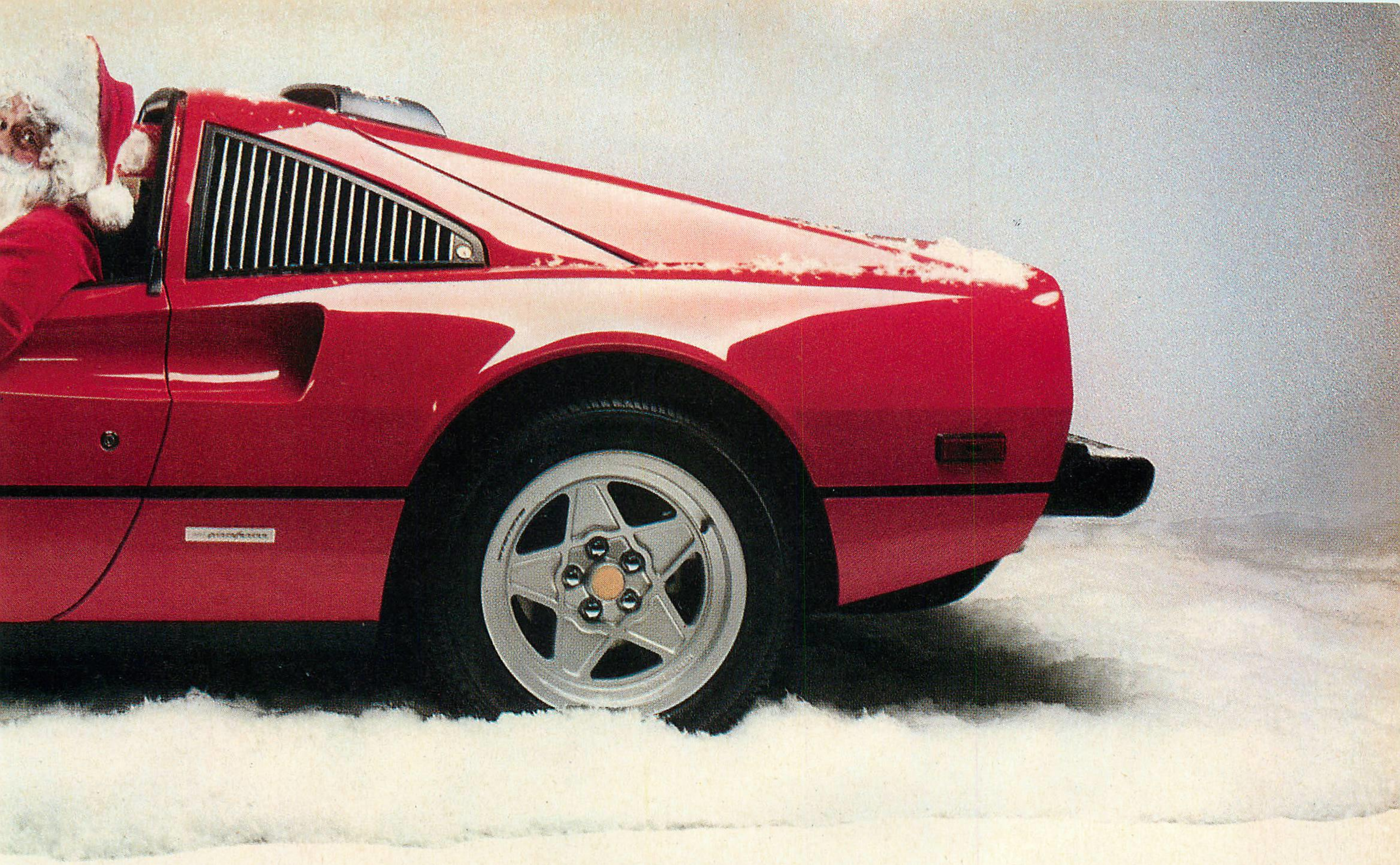

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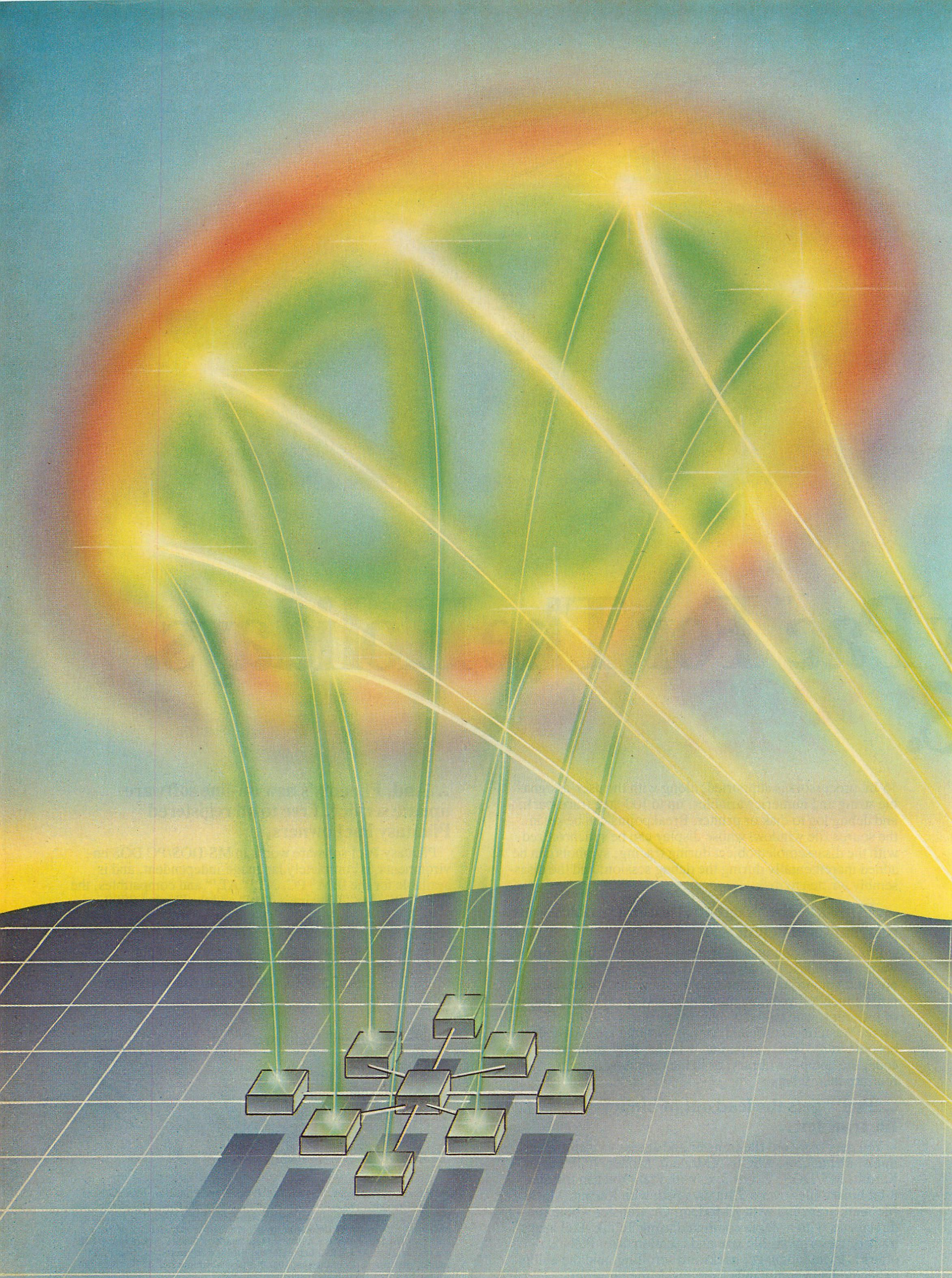

NetWare in Control

Novell's network operating system offers superior performance and security in LAN hardware; it is rich in function and widely compatible.

ART KRUMREY

Simplicity and sophistication: in the most elegant application they can approach synonymity. Responses received by PC network designers underline the fact that users want both. Their PCs are simple and they do not want to see that simplicity confounded by the complexities of a network (that reeks of mainframe). The same users, however, want to employ laser printers, share data, send electronic messages, and protect software from copyright violations. Novell NetWare, a PC network operating system that runs on 24 different makes of LAN hardware, offers PC users a fine balance.

NetWare is at once simple and sophisticated; it allows the system manager to set up users on the network without their needing to understand it fully. The LOGIN script and AUTOEXEC.BAT files work together nicely to automatically provide a user with full network services. In one NetWare application, when the administrative staff at a university turns on its PCs, the AUTOEXEC file signs them onto the network, and the LOGIN script maps file server directories to the network disk drive (like virtual diskettes); diverts LPT1 to a shared, spooled, multimode printer and LPT2 to a laser printer; and checks the NetWare electronic mail file. If mail is present in the file, the script pauses in that system to allow the user to check his mail. When that step is complete, or

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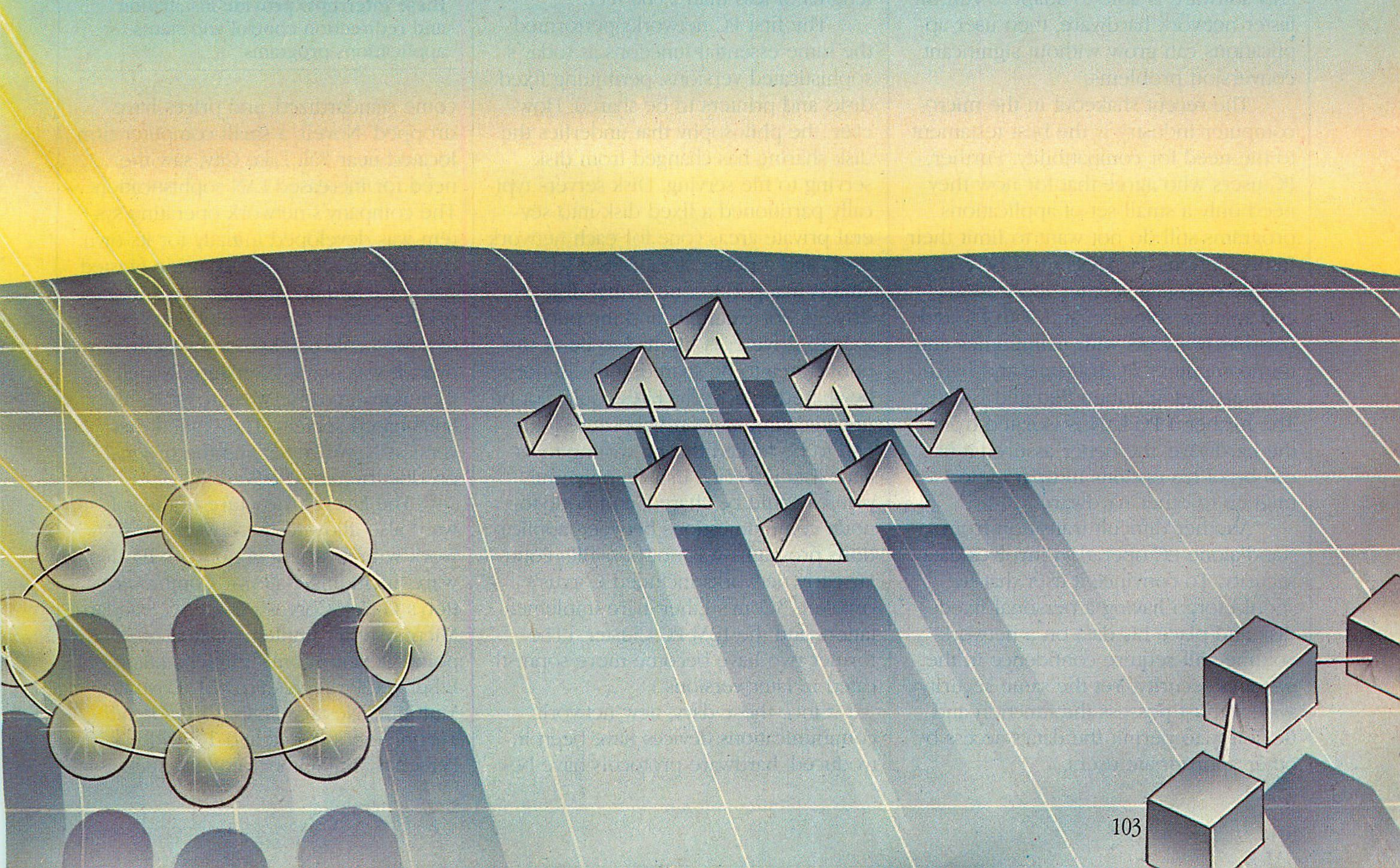

if no mail is present, the script proceeds to establish a hot-key IBM 3270 emulation session (through a network communications server), a hot-key utility to release NetWare spooled print files, and finally leaves with the user's default directory pointing to the area in which he normally stores files.

PC network designers and managers share obvious priorities: reliability and responsiveness are requisite. But as business climates become increasingly complex and user expectations continue to be fueled by advertising that oversimplifies complex problems (such as micro-to-mainframe links), users are demanding more from their workstations. PC LANs also must be richly functional, flexible, compatible with industry standards, easy to use, and offer good security and performance.

A more advanced group of users, for example, may want to use a quality laser printer, as well as other shared printers, from each of the workstations. They may want to access data that are on another department's LAN, or use its printer. Several users may need to access the organization's mainframe. In another situation, LAN use may increase to the point where faster network transmission speeds are needed or the network must be split. The LAN must be flexible enough to allow bridging or gateways to other networks, for example, a mainframe SNA network. If the LAN software is able to adapt to run on faster network hardware, then user applications can grow without significant conversion problems.

The recent shakeout in the microcomputer industry is the best testament to the need for compatibility. Further, PC users who agree that for now they need only a small set of applications programs still do not want to limit their future options. PC LANs must be compatible with mainstream applications and systems software, and with PC and LAN hardware. As with mainframes and minicomputers, PC software and hardware are being unbundled and isolated. The further a PC LAN is isolated from the hardware, the better assured a user can be of his options to upgrade or migrate to other hardware.

Another difficult transition from stand-alone PC operation involves data security. To convince a user that he should forgo having a personal fixed disk and place his data on a network volume will require confidence in the system's security. Yet the same security system must possess the function and flexibility to permit the data's access by other appropriate users.

The LAN also must perform well. If it does not, the inherent speed benefits of the microcomputer are lost and users will grumble that their PCs are no better than a slow mainframe. Users are demanding increased function and expect no compromise in speed. Working with shared network software should be faster than loading from a floppy disk, as should using a shared, spooled printer.

Like good PC software, a LAN must be easy to use. Introducing a seasoned PC user to a LAN should not require retraining for basic functions. The added value of network capabilities should come as natural extensions to native PC procedures, or be intuitively consistent with organizational needs. For example, it should be easy to arrange users into groups for security purposes. Lose the ease of use and the user will want to return to the simpler stand-alone days.

CURRENT LAN MARKET

The IBM PC was introduced at the same time that advertisements for EtherNet were hawking the universal connection for office systems. That connection has yet to become universal because firms are reluctant to install networks broad enough to encompass entire office complexes or campuses due to high capital costs and uncertainty about future compatibility. Interest has increased, however, in departmental LANs that connect nearby workstations, with total cable lengths of less than 2,000 feet.

The first PC networks performed the same essential functions as today's sophisticated versions, permitting fixed disks and printers to be shared. However, the philosophy that underlies the disk sharing has changed from disk serving to file serving. Disk servers typically partitioned a fixed disk into several private areas (one for each network user) and a public area. A user's private area is mapped to one virtual disk, drive d:, for example, and the public area to drive e:. A file had to be in the public area to be shared; it could not be shared selectively. Files could not be updated simultaneously because a file had to be locked during writing to assure data integrity. Usually only one printer could be shared, and node-to-node communications between applications programs was not possible. Popular early networks included Corvus's OMNINET, 3Com's EtherShare implementation, and the IBM PC Cluster. (The former two have become more sophisticated in later versions.)

Since those days, new network communications devices have been introduced, hardware protocols have become standardized, and prices have dropped. Novell, a small computer firm located near Salt Lake City, saw the need for increased LAN sophistication. The company's network operating system was developed initially for its own hardware: a star topology using twisted pair wire and a Z80-based file and printer server. Once it had been ported to a Motorola 68000-based system, however, it was named NetWare. Novell then converted NetWare to 8086- and 8088-based servers. They called that version NetWare 86, and the original product became NetWare 68.

The layered structure of the software also allowed its conversion to work with a variety of network hardware, including Gateway Communication's G-Net, Corvus's OMNINET, Standard Microsystem's implementation of Datapoint ARCNET, 3Com's implementation of EtherNet, Proteon's ProNET, Davong's Multilink, Nestar's PLAN 2000, Orchid Technology's PCnet, and Televideo's Personal Mini. Other vendors, such as

TABLE 1: *IBM Interface*

AH	AL		INT 21h
3D			Open file with sharing specified
44	09	IOCTL	Is device redirected?
	OA	IOCTL	Is handle local or remote?
	OB	IOCTL	Change sharing retry count
59			Get extended error
5A			Create temp file w/ unique name
5B			Create new file
5C	00		Lock byte range
	01		Unlock byte range
5E	00		Get machine name
	02		Set up printer control string
5F	02		Get assign list entry
	03		Redirect device to net
	04		Cancel redirection

AH	INT2Ah
00	Installation check
01	Exec NetBios request
02	Set net printer mode
03	Get device shared status

AH	AL	INT 2Fh
BB	00	Net command installation check
	03	Get server post address
	04	Set server post address

The program interface to the IBM PC Network consists of the above; these interrupts provide installation and redirection control and status for applications programs.

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Quadram Corporation, bundle one of the above systems with NetWare.

The different implementations of NetWare are identical except for the drivers closest to the network hardware. The software is compatible and both the applications software and data can be preserved in a network upgrade. For example, if the slower speed of a network based on a one-megabit twisted pair becomes unacceptable, applications, say a multiuser database, can be ported to a network based on a coaxial cable running 10 megabits. However, the network applications software may be keyed or *serialized* to the serial number of the special network interface card in the server; the record of this serial number in the software may have to be changed. This is part of the Multiple User Software Licensing System (MUSCLS), a collection of utilities Novell makes available to software developers who wish to develop networking versions of their products.

MUSCLS includes several features unique to NetWare: .EXE and .COM files can be marked execute only, allowing them to be run through the network, but not copied. This feature is important in an open environment, such as a university computing laboratory, where software must not be copied in violation of license agreements or state and federal copyright laws. MUSCLS enables the developer to use the network to control the number of simultaneous users of its product: a quantity figure can be coded into the version shipped to the user. The developer can later provide a patch when more users are needed and paid for.

NetWare is a true file server in which directories or files on the server's fixed disk are mapped to network drives, like virtual diskettes. The server runs a proprietary, multitasking operating system, but its file structure is consistent with DOS 2.x and 3.x hierarchical directories. The NetWare shell in the user's PC intercepts all DOS 21H calls and redirects appropriate calls to the server. File allocation table information is maintained in the server, not in the user's station, which helps ensure data integrity. Multiuser database management systems can use logical or physical record locks, or transaction updates that hold a file exclusively for a read/update/write cycle.

In late 1984, IBM announced its PC Network. Critics were confused by inconsistencies with the company's stated direction in token-ring protocol and the IBM wiring plan. The selection of broadband hardware, with its radio-frequency modulation complexities, also was surprising: broadband is common when a network is to transmit video and voice in addition to data.

TABLE 2: *NetWare Shell Program Interface*

AH	AL	INT 21h
BB		Extended open file
BD		Release physical record
BE		Clear physical record
BF		FCB log physical record
C0		FCB release physical record
C1		FCB clear physical record
C2		Lock physical record
C3		Release physical record set
C4		Clear physical record set
C5	00	Open a semaphore
	01	Examine a semaphore
	02	Wait semaphore
	03	Signal a semaphore
	05	Close a semaphore
C6		Get and set lock mode
C7	00	Begin transaction update
	01	End a transaction update
	02	Trans. back-out available?
C8		Begin transaction
C9		End transaction
CA		Log personal file
CB		Lock file set
CC		Release file
CD		Release file set
CE		Clear file
CF		Clear file set
D0		Log record string
D1		Lock record string set
D2		Release record string

AH	AL	INT 21h
D3		Release record string set
D4		Clear record string
D5		Clear record string set
D6		End of job
D7		System log-out
D8		Allocate resource
D9		De-allocate resource
DA		Get volume statistics
DB		Return number of local disks
DC		Get station number
DD		Set error mode
DE		Set broadcast mode
DF		Modify LST device
E0		Print spooling request specification
E1		System pipe request specification
E2		Directory request specification
E3		Log-in request specification
E4		Set file attribute
E5		Update file size
E6		Network file to file copy
E7		Return time date string
E8		Set close mode
E9		Get shell base status
EA		Return shell version
EB		Log file ASCIIZ string
EC		Release file ASCIIZ string
ED		Clear file ASCIIZ string

In addition to emulating the PC Network Program interrupt calls, NetWare also provides extended network calls, which are listed above.

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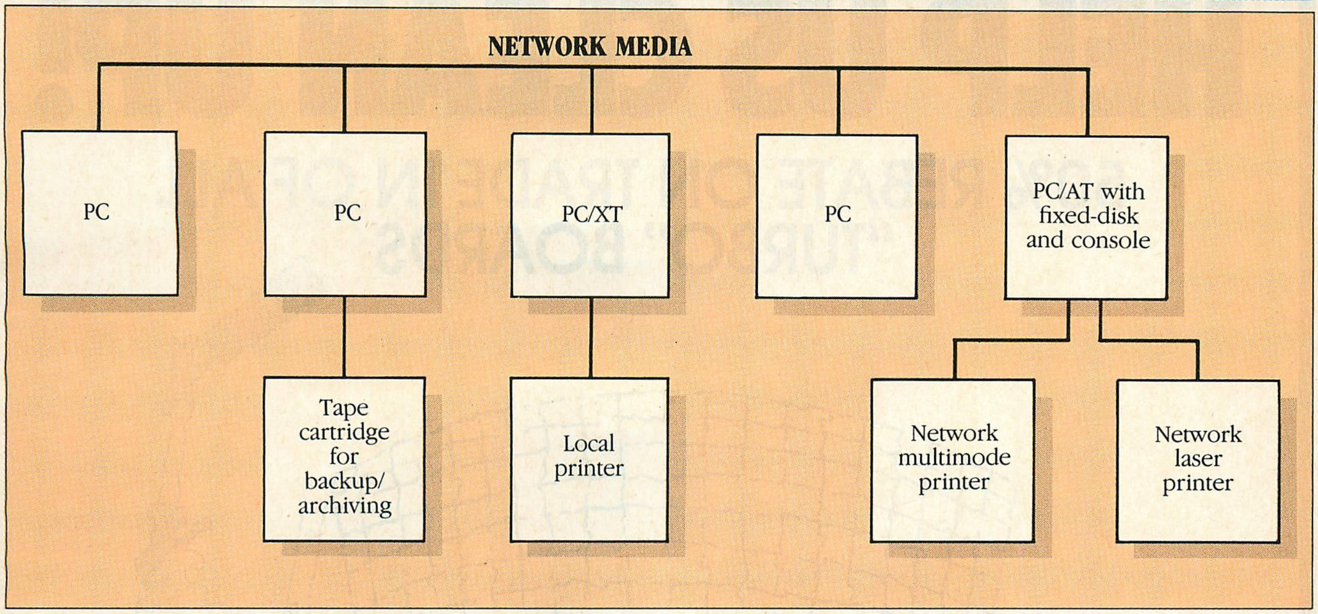
IBM began shipping the Network hardware in 1984, but the companion software was not released until spring 1985. The IBM Network program was disappointing to some: it offered only negligible security, average printer management, and limited performance. But it defined a DOS interface that went beyond the existing interrupt 21H operations and which became a defined part of DOS 3.1; the product's IBM tag also helped to legitimize it. Moreover, skeptics of networking philosophy now had to consider its embrace by Big Blue.

The IBM PC Network program is based on Microsoft's Networks program (a relationship similar to that of PC-DOS and MS-DOS). Microsoft also is adapting Networks to run on many vendors' network hardware, so that it will be competing with NetWare as an alternative to hardware vendors' software. Networks presently has the same limitations as the IBM PC Network program, but the companies can go in divergent directions now that the interface to applications and workstation operating systems is well-defined. In fact, IBM has added to Networks for its program; the two products are not identical.

Novell responded to IBM compatibility in three ways. First, all versions of NetWare will be compatible with the new DOS 3.1 definitions for interrupt 21H operations (shown in table 1) and include the additional functions (see table 2). Second, the NetWare/PCN version runs on the IBM Network. Finally, an announced product, the Novell NetWare NETBIOS emulator, allows the IBM PC Network program to be run on a workstation in a network otherwise running NetWare. Advanced NetWare added the handling of multiple servers on one network and the bridging of two or more networks running on the same or dissimilar hardware, as well as additional functions through unused codes in interrupt 21H.

The stage for competition is set: IBM, Microsoft, and Novell are the major players in the LAN software arena.

FIGURE 1: *A Typical Single Server PC Network*



Each workstation in the network is booted with standard DOS from a floppy disk. Then the NetWare shell is loaded; it resides immediately above the resident part of COMMAND.COM. The shell intercepts all interrupt 21H calls and distinguishes between requests for local drives and network drives that are equated to files or directories on the network file server. Calls for local drives are passed on to DOS, but calls for network drives are assembled into a packet, which is sent by the network interface driver and network medium to the file server.

With DOS 3.1 defining the rules, network designers are free to make vendor selections without limiting their options. NetWare is the oldest, most mature of the three and is positioned to continue as an attractive alternative to both IBM and Microsoft networks.

Advanced NetWare was recently released for most 8086 network hardware. Its principal new features are the support of multiple file servers and the ability to interconnect NetWare Operating System networks of either the same or different network hardware. For example, a Novell S/Net star network can be linked to a ProNet network (Proteon hardware, including fiber optic media) which in turn is linked to an IBM PC Network, assuming all are running Advanced NetWare. This is accomplished through bridges, typically a PC with both media's network cards and special bridge software. The Advanced product also allows the development of value-added servers to communicate with devices that are not directly compatible with the NetWare Operating System, using a protocol based on Xerox's Internet Packet Exchange.

AT YOUR SERVICE

A typical single-server PC network is shown in figure 1. Each workstation is booted with standard DOS from a floppy disk. Then the NetWare shell is loaded; it resides immediately above the resident part of COMMAND.COM. The shell intercepts all interrupt 21H calls and distinguishes between requests for local drives and requests for network drives that are equated to files or directories on the network file server. Calls for local drives are passed on to DOS, but calls for network drives are assembled into a packet, which is then sent by the network interface driver and network medium to the file server. When the server responds, the shell receives the reply through the network and satisfies the DOS call with information from the reply packet.

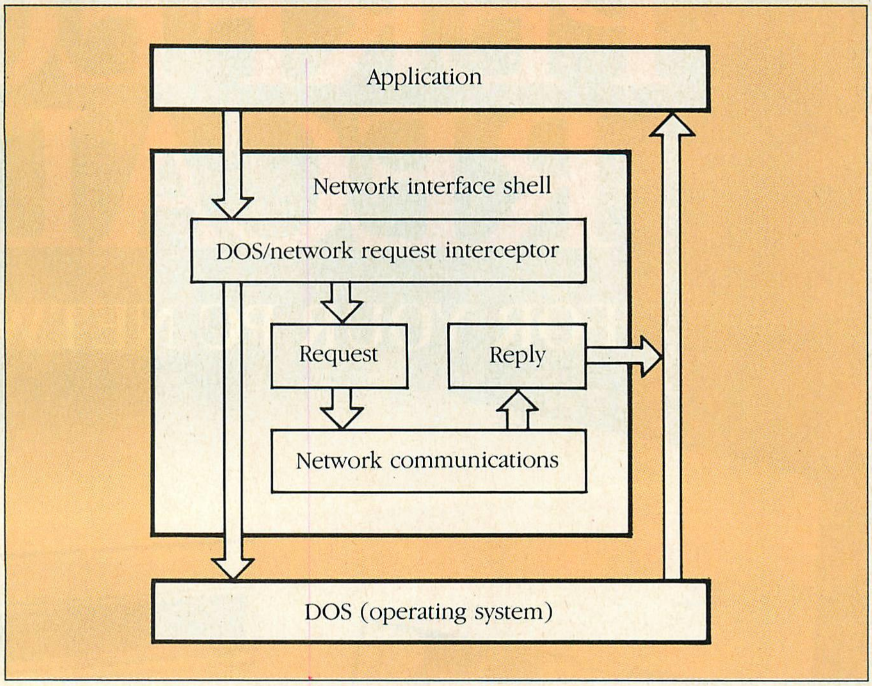
> *All versions of NetWare will be compatible with the new DOS 3.1 definitions for 21H interrupts and will include the additional functions. NetWare/PCN runs on the IBM Network.*

The shell's relationship to other software in the workstation is shown in figure 2. Its function is similar to the IBM/Microsoft redirector. All three networks use the term *server* to describe the node that satisfies data requests directed through the network, but its function in each differs radically.

The IBM and Microsoft servers are built around DOS—see figure 3, which also shows a typical user workstation. Every request to the server passes to the network control program from the Network BIOS. The control program passes it to the file/print server application, which formulates it into a server DOS request. This is presented to DOS after being filtered again by the redirector. A layer below DOS checks for file hardware locks before the request is sent to BIOS and the disk hardware.

Novell's file server is shown in figure 4. Each circle is a task of the multitasking operating system. The supervisor process oversees all operations and ensures that service requests are sent directly to the appropriate service process. The operating system ensures that network requests do not have to pass through DOS; they are sent to the appropriate server module. The server can respond to several requests simultaneously. While two users' requests are waiting for the completion of I/O to the server's disk, a third process may be satisfying a query about the other users on the network, and the print spooling process may be sending a buffer of lines to a printer.

FIGURE 2: *Interface Shell Block Diagram*



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The network interface shell intercepts each application request and checks to see if it needs to be processed by the file server or sent on to DOS for handling.

NetWare's file, print, and communications server functions must be started by console commands or NetWare DOS calls. For example, printer data normally sent by an applications program to LPT1: can be redirected to NetWare's spooling services either by the NetWare SPOOL command or by a call to function request interrupt 21H function number E0H (see table 2). NetWare's user interface consists of four categories of commands as shown in table 3. Almost all of the commands listed are present in both basic and Advanced NetWare, although ATTACH was added for the multiple file servers of the Advanced product only.

MYCON is a powerful program driven by fast and friendly overlaying menus; it is a subset of the supervisor's principal security management tool, SYSCON. MYCON/SYSCON provide an elegant replacement for several basic NetWare discrete commands, specifically GRANT, ERASEDIR, REVOKE, TLIST, FLAGDIR, MAKEDIR, RENDIR, GROUP, MAKEUSER, PASSFIX, and PASSWORD. This menu-driven consolidation of commands is inconsistent with the other user commands, whch are similar to DOS commands. MYCON/SYSCON are an environment to themselves with a set of notational conventions that requires 8½ pages of explanation. For example, the name of a security group can be changed in MYCON, but the user has to know that he must type an asterisk over the old name to be prompted for the new name.

It is easy to speculate that Novell eventually may put all or most commands in MYCON, or, more expeditiously, put related commands into one of several MYCON-like commands. The original commands may need to be retained for LOGIN scripts and .BAT files. The ideal next step is to have the menu versions available through hot-keys, like the IBM PC Network program.

The most specific need for such a hot-key facility is to control the spooling of print files. Consider a user working with a spreadsheet program. He wishes to change a few cells, recalculate, and print the results. LPT1 was redirected to a spooled network printer before the spreadsheet program was called. Using either basic or Advanced NetWare, the user would have to save his spreadsheet, exit from the spreadsheet program, and use SPOOL or ENDSPOOL to release the print file.

NetWare versions of some applications programs, such as Satellite Software's WordPerfect, release the print file through the Novell DOS call. For general purposes, however, the print file would be released ideally by a hotkey or pull-down menu. Advanced PC Solutions sells a program called Hot-Print that performs this task and more; it allows the user (by means of 15 Alt-shift-letter/number combinations) to release, respool, and specify forms, copies, alternate printers, and banners. These jobs can be accomplished from within an applications program, but because no menu assists the user, he must either remember or look up the applicable hot-key combination.

The HELP facility is complete, but awkward. For example, typing HELP MAP at the command prompt would get the user into the facility, but it would not automatically supply information on the MAP command. Instead, the test of the HELP command is expected to be an English question; for example, HELP HOW DO I MAP NETWORK DISK DRIVES? If the operand is not in this form, the user is informed that the question was not understood. He then has to step through a set of five help menus to get any help on MAP.

In addition, while it is reasonable to expect a conventional function key, F1 for example, to deliver help from MYCON (as it does in SETLOGIN), this is not the case. This AI-like interpretation of English-like questions is impressive, but a faster route to information on the command in question might be better appreciated. Also, Esc does not exit HELP, rather it allows the user to ask a second question; pressing Ctrl-C exits the HELP facility.

This need for an immediate path to HELP is illustrated below by the powerful SPOOL command. NetWare's printer management is exemplary in its versatility; the rich options available with this command attest to the fact:

SPOOL [/flag list]
/flag list
/flag/flag../flag
flag flag..flag
flag may be as follows:

Tabs	**a number from 1 to 18**
Copies	**a number from 0 to 255**
Forms	**a number from 0 to 255**
[ON]Server	**file server to which printer is connected**
[TO]Printer	**a number from 0 to 2**
Banner	**ASCII string**
Create	**directory/filename**
No Tabs	
No Banner	

An installation may have two printers on its file server named FS2. The first might be a multifunction near-letter-quality matrix printer and the second a laser printer. This NetWare SPOOL command might be used to reproduce a spreadsheet on letterhead using a custom form that has the number 87:

SPOOL C=8 F=87 P=1 NB

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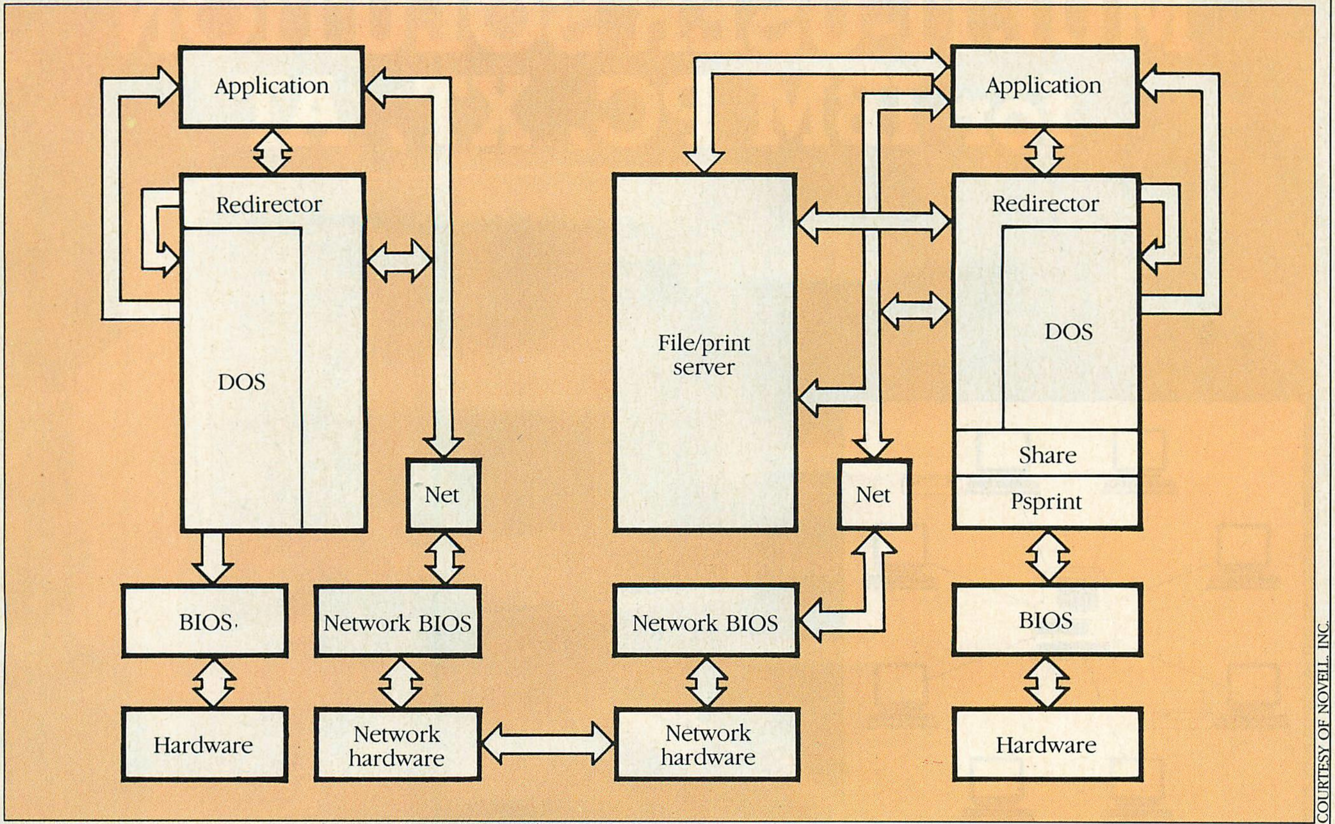
FIGURE 3: *IBM PC Network Block Diagram*



The workstation is to the left, file server to the right. The IBM PC Network philosophy is very different from Novell's, mostly because IBM owns both the Network BIOS and DOS itself. The file server itself is actually an applications program.

This command would yield eight copies on form 87 on network printer 1, without a banner (which minimizes laser printer usage). The operands of the SPOOL command are mnemonic, but fast help is nonetheless essential to the infrequent user of the system.

SETLOGIN is the tool that best avails the user of full access to NetWare's resources while shielding him from its complexities. This command defines a LOGIN script, which is like an AUTOEXEC.BAT file. The script command set includes an IF statement, built-in identifiers like LOGIN_NAME, time, OS_VERSION, and NEW_MAIL, indicating that new mail is waiting for the user. NEW_MAIL could be used in an IF statement to place users in the mail system at the end of the script, to ensure that they will be notified of their mail when logging on.

All external DOS commands can be used in a SCRIPT, but internal commands are not allowed. Thus the PROMPT DOS command cannot be used to specify a standard DOS prompt for a work group. (The AUTOEXEC file can be used for this.) The IF command also lacks an OR logical operator, although it does provide AND. IF commands cannot be nested, which makes it necessary to conditionally INCLUDE one LOGIN script into another, if the included script also contains IFs.

The LOGIN script allows the user or manager to define an initial set of network drive mappings. If initial mappings are done carefully, users can access needed files without necessarily knowing hierarchical directory structures or, in a multiple server network, upon which server a directory resides.

Finally, the FIRE PHASERS command can be used to call the user's attention to the workstations. In spite of its whimsical name, it is described seriously in the manual: "The FIRE PHASERS command allows you to generate a shooting noise any number of times by specifying FIRE PHASERS *n* TIMES, where *n* is the number of times you wish to hear this strange sound." (The number was later limited to 10.)

CONSOLE COMMANDS

The NetWare file server is controlled by a set of console commands that fall into the same categories as the user commands (see table 4).

Advanced NetWare's printer controls are probably the richest of any PC LAN, rivaling those of a production mainframe. Its form management is excellent, and the ability to rearrange jobs is quite valuable. The CONSOLE queue command indicates priority, number, directory area, file name, and release times for each job in the queue, and shows the printer status. CHANGE QUEUE enables the server operator to alter the position of jobs in the queue.

This full function is especially valuable when fast printers or laser printers are shared among groups of users. It would be more accessible if console commands were consistent with user commands in syntax and displayed result. For example the user QUEUE command must be abbreviated to Q and adds the banner name, number of copies, form number, flags, station number, and user identification (ID). Ideally, both commands should function identically; moreover, several pieces of information on the user display, such as form number and user ID, would be most valuable on the console response to QUEUE. It would be useful to know the number of lines or bytes in the queued file as well, but not even IBM's mainframe spooling control program JES 2 boasts that feature.

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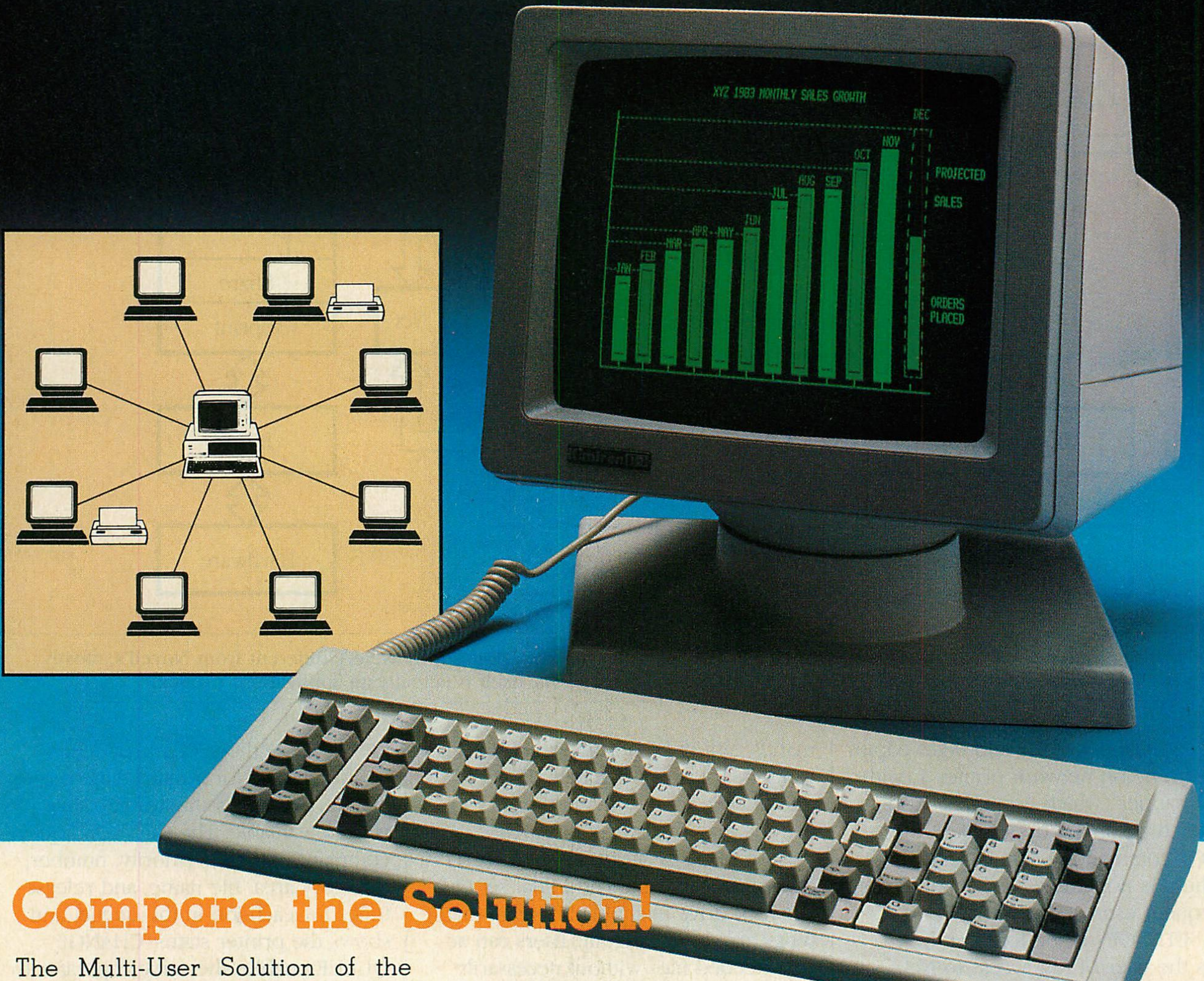

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The user SEND command requires a list of user IDs for the destination; the console SEND command requires station numbers. Besides this inconsistency, the station numbers in NetWare 86 are assigned dynamically, and it is not possible to find the station number of a user by his ID from the server console.

The console MONITOR command displays certain information on the five most recent files requested by a station: name, status, the transaction status and semaphores for each station, and performance parameters such as the percent of file server utilization and the number of disk cache blocks not yet written to the server's disk. Despite its

SETLOGIN is the tool that best avails the user of full access to NetWare's many resources while shielding him from the LAN's inherent complexities.

omission of the station's user ID, the display is invaluable to network managers for resolving file lockout questions and performance bottlenecks.

On-line help and optional abbreviations would make using the console commands a lot easier. At least the DOS function keys could help in repeating previously typed commands. Other helpful capabilities would include control of server printers from an authorized workstation and console control of printers on another network server. If the server is left in an unsecured area, it would be useful to be able to optionally require console LOGIN to execute commands such as CLEAR STATION, DOWN, and DISABLE/ENABLE LOGIN. This is only a wish list, not a list of unfulfilled requirements; the command set is complete as it is.

SECURITY RIGHTS

The sophistication of NetWare is best displayed by its security. The structure seems unnecessarily complex at first, but experienced network managers have seen the need for security grow as their work groups have become increasingly dependent on their PCs.

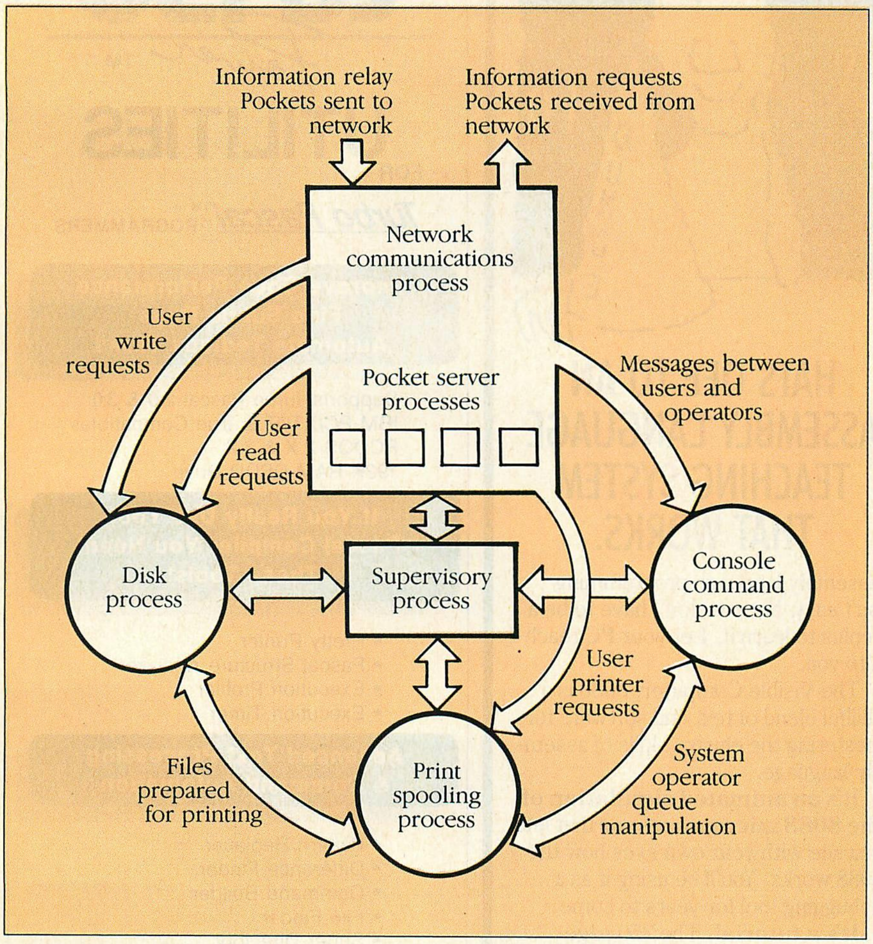
Consider, for example, a spreadsheet that plans salary increases. At first, the network-shy department head keeps it on a floppy disk. But when changes need to be made by another person, he is back to exchanging floppies again— and these are disks containing critical information that should be backed up like other shared data.

File server security is managed in four ways: login/password, trustee, directory, and file attributes. Every user must have an ID which is associated with him, not a machine (as is the case with the IBM PC Network). In this way, NetWare offers better security for situations in which different users share a given machine, as is often the case in a university microcomputer laboratory or an office workroom.

A user logs onto each file server separately; the password is not shown on the screen as it is entered. Security for each file server is handled independently of all others. Users can be aggregated into groups for ease of allowing group members privileges to files or directories. Users or groups who have been entrusted with such permissions are called *trustees*. When a user is first permitted to log into a server, he is powerless until the system manager gives him rights in one or more directories. No native area exists where a user may create files until it has been explicitly permitted.

The system manager is the ID SUPERVISOR, a very special ID that includes all rights to all files, directories, and passwords *on that server*. It is not necessary, nor is it possible, to add the user as a trustee. This is perhaps the security system's biggest weakness. In the early days of mainframes, it was assumed that system managers would have open access within security systems; however, more mature systems, such as Access Control Facility 2 (ACF2), have a system of checks on the manager's privileged accesses. In particular, they are logged, and the access logs are automatically printed for another manager, say the manager whose area owns the data. It may not be desirable, for example, for the technical system manager of a network in a small company to have access to everyone's personnel in-

FIGURE 4: *NetWare Operating System*



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The supervisor oversees all execution within the system. File server requests are handled specifically by the network communications process.

formation. While less all-encompassing than ACF2, NetWare's security is the best offered by a LAN.

A trustee on the network has certain assigned rights; each directory has a mask of rights that limits access to it. A trustee's rights in a directory extend to all its child subdirectories unless an explicit specification for a particular subdirectory appears elsewhere in the trustee's rights. In that case, the new specification of rights takes precedence for that subdirectory and all of its own child subdirectories. The eight types of rights are as follows:

R — Read from open files
W — Write to open files
O — Open existing files
C — Create (and open) new files
D — Delete existing files
P — Parental, meaning:
  Create, rename, and erase subdirectories
  Set trustee and directory rights in these subdirectories
  Set trustee and directory rights in the directory
S — Search the directory
M — Modify file attributes

The distinctions among open, read, and write permit some very tight specifications. For example, a user might be allowed to create, read, and write files in order to add to a particular directory, without being granted access to files that already exist in that directory. Granting a trustee ROW (read/open/write) rights, but not the search right, enables him to access only those files for which he knows the name.

The file attributes controlled by the M right are read-write/read-only, nonshareable/shareable, hidden, and system. The M right also allows the following extended information to be changed: date and time the file was last updated, date the file was last opened, and date the file was created. The ability to change this date and time information seriously detracts from the auditability of the file system and should be limited as much as possible.

The supervisor can assign trustee rights to an individual user or a user group, and he can assign a user or group as having equivalent security to another user or group. One special group, EVERYONE, indicates just that—everyone is a member. Thus, a user's trustee rights are the union of:

- Rights assigned to the individual ID
- Rights assigned to the groups in which the ID is a member
- Rights or IDs or groups to which the user has security equivalence
- Rights of the group EVERYONE

TABLE 3: *NetWare User Interface Commands*

SESSION MANAGEMENT	
NETx0y or ANETx0y	Establish network connection using x version of DOS on y implementation of NetWare
ATTACH	Use a second file server
LOGIN and LOGOUT	Log into system with security clearance and log out
CASTON and CASTOFF	Control interruption by messages
SETLOGIN	Define a LOGIN script of initial network disk drive mapping, optionally execute programs, check mail, etc.
SYSTIME	Synchronize a workstation's clock with the file server's clock
FILE SERVICE MANAGEMENT	
NPATH (MAP in Advanced)	Map network driver to server directories
CHKVOL	A network CHKDSK
LISTDIR	List subdirectories and their access privilege status
SHOWDIR	Show the structure of an entire directory
VOLINFO	Display total and free space on network volumes
SALVAGE	Recover files after they have been erased
PURGE	Permanently erase files that have been marked for deletion by a previous erase
LARCHIVE and TARCHIVE	Archive network files to a local drive or tape cartridge
TRESTORE	Restore archived files
UDIR	Search an entire network volume for a file name matching a wild card
MYCON	Specify and display access rights to files and manage directories, user, and group information
FLAG	Set file attributes such as share status
RIGHTS	Display the effective rights a user has in a particular directory
PRINTER MANAGEMENT AND SPOOLING	
SPOOL	Redirect output normally sent to a workstation's local printer to the network spooler and printer
ENDSPOOL	Cancel the redirection and release the file for printing
QUEUE	Display the print queue
NPRINT	Directly print a file on a network printer.
MISCELLANEOUS	
SEND	Send messages
USERLIST	List network users
WHOAMI	Display user characteristics
HELP	Assistance with system

Almost all of the commands listed are present in both basic and Advanced NetWare, although ATTACH was added for the multiple file servers of the Advanced product. MYCON is a powerful program driven by fast and friendly overlaying menus; it is a subset of the supervisor's principal security management tool, SYSCON.

A user's effective rights in accessing a directory within the network are this union, limited by (intersected with) the maximum rights mask of the directory itself. The final file rights are further limited by the read-write/read-only attribute. With this attribute set, no one can write to the file without first changing that attribute.

Every directory has a maximum rights mask, which is initially set to all rights. When necessary, the supervisor or user with Parental rights can edit the mask to prevent trustees from exercising rights that they otherwise would have in that directory. Such restrictions apply only to the immediate directory, not to subdirectories under it.

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CIRCLE NO. 195 ON READER SERVICE CARD

For example, consider a user SUE who is a member of GROUPA and GROUPB. Because SUE is a member of GROUPA, she has ROW to directory PAYABLES. Because she is a member of GROUPB, she has RWOCS. Because she is SUE, she has RWOCM. Her effective rights for directory PAYABLES is the union of these rights, or RWOCSM. But if subdirectory LETTERS has a rights mask RWOCDPS (omitting M), she cannot change attributes of files in that subdirectory. If a different subdirectory SUSPENSE of directory PAYABLES has a file called LONGTERM.DAT with the attribute read-only, SUE could write to it if she first changed its attribute to read-write, which she can do because she has the M right in directory PAYABLES.

SYSCON AND MYCON

Security rights, trusteeships, file attributes, ID creation, group memberships, equivalences, and directory management are all handled in a single menu-driven program in Advanced NetWare. Two versions are present, SYSCON for the supervisor and MYCON for users. MYCON, a subset of SYSCON, primarily eliminates the user ID and group creation function. Most other functions, however, can be performed if the user is a suitably powerful trustee.

Basic NetWare uses the commands GRANT, REVOKE, TLIST, FLAGDIR, MAKEDIR, RENDIR, ERASEDIR, GROUP, MAKEUSER, PASSFIX, and PASSWORD to perform these operations. The menu-driven versions are much easier to use because they help the user or supervisor remember the security structure and command options. The old commands should be retained by Novell because it is often convenient to put commands into a .BAT file for frequently performed operations. (The last four commands in the above list were eliminated in Advanced NetWare V1.0.) An example is a monthly close of accounts in which a new subdirectory might be created, file attributes set, and old files archived. The group membership concept does, however, limit the need for the repetitive operations needed to give a new employee proper rights.

The SYSCON primary menu is shown in photo 1. The user operations supported include creation and deletion of IDs and passwords, the definition of equivalences, trustee assignments, specification of group memberships, and display and control of disk space use. Photo 2 shows trustee display and assignment; the display can be edited. Photo 3 shows the groups of which user $ACSPJC is a member.

TABLE 4: *NetWare Console Commands*

SESSION MANAGEMENT	
CLEAR STATION	Disconnect a network user
DOWN	Shut down the file server
ENABLE LOGIN and DISABLE LOGIN	Control access
BROADCAST	Send messages to all users
SEND	Send messages to stations by station number
FILE SERVICE MANAGEMENT	
MOUNT and DISMOUNT	Pack to change a removable volume
PRINTER MANAGEMENT AND SPOOLING	
CHANGE QUEUE	Change the order in which queued files are printed
FORM CHECK	Align continuous-feed paper
FORM SET	Form feed the printer
KILL PRINTER	Stop a printer and erase all jobs from its queue
QUEUE	Display print jobs
REROUTE PRINTER	Reroute all print jobs to another printer
REWIND PRINTER	Back up a printer the specified number of pages
START PRINTER	Restart a stopped printer
MISCELLANEOUS	
CLEAR MESSAGE	Clear the message line on the console screen
CONSOLE	Switch a nondedicated file server from local DOS mode into console mode
DOS	Switch a nondedicated file server from console mode into local DOS mode
MONITOR	Display network activity for a six station group
OFF	Cancel the MONITOR display
SET TIME	Set the server date and time
TIME	Display the server date and time

NetWare's printer management is excellent. The console QUEUE command indicates priority, number, directory area, file name, and release time for each job in the queue, and shows the printer status. CHANGE QUEUE enables the server operator to alter the position of jobs in the queue. This full function is especially valuable when fast printers or laser printers are shared among groups of users.

TABLE 5: *LAN Performance Comparison—DBMS*

LAN HARDWARE	NATIVE LAN OS	NOVELL NETWARE
3Com Etherseries	355	228
Corvus Omninet	307	215
Davong Multilink	209	201

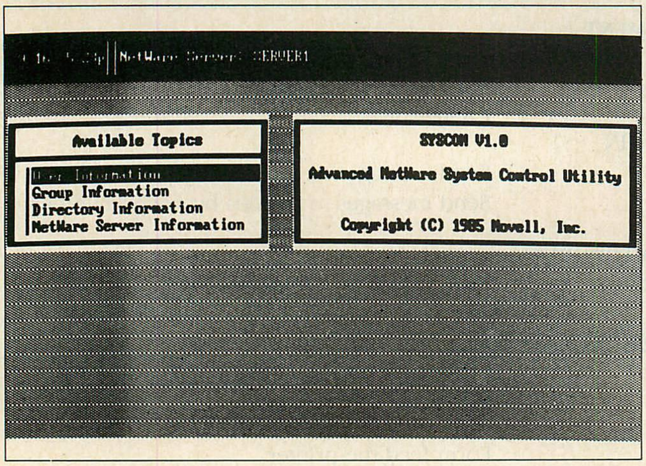
All timings represent the number of seconds to process 100 database records on a PC/XT. Both tests were performed on one workstation in a four-workstation configuration, while the other three stations performed other applications.

The group operations allow the management of group lists and group trusteeship. Group composition can be changed using either the user or group SYSCON menu, but the display orientation is different: the user menu shows the groups to which one user belongs, the group menu shows which users are in a particular group. Photo 4 shows a group list; selecting a group name on this menu would show its composition.

The directory menu allows the display of directories, directory trustee lists, file attributes and information, and the maximum rights mask. Photo 5 shows the directory's owner, creation date, and rights mask. Photo 6 shows the trustees of directory PUBLIC/DOS20 on volume SYS. Rights can be changed here or on the user menu.

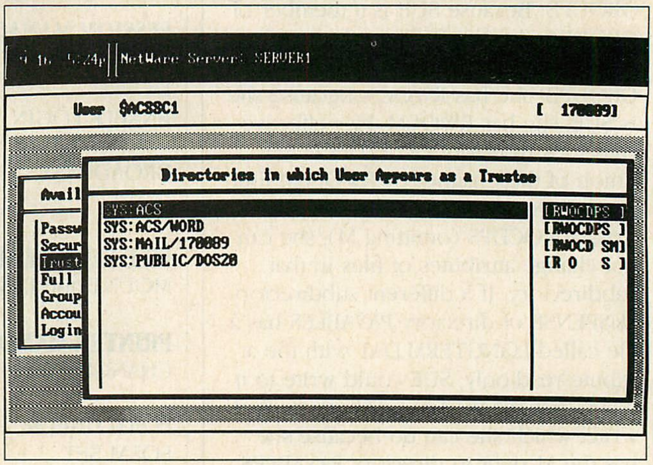
The NetWare server menu is also an important SYSCON option; it displays

PHOTO 1: *SYSCON Primary Menu*



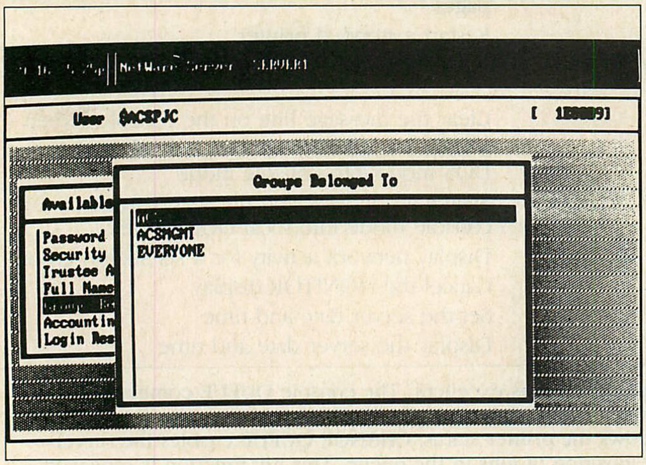
This menu is for the system supervisor. From it he may create and delete IDs and passwords and assign trustees.

PHOTO 2: *Trustee Display and Assignment*



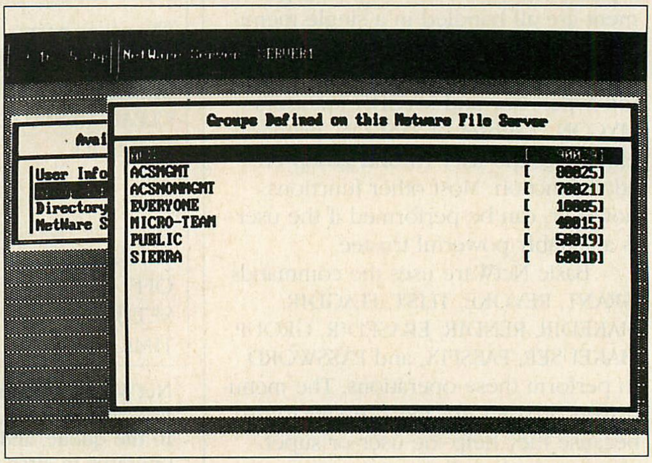
The member of a user group is called a *trustee*; as shown above, he has assigned privileges to certain directories.

PHOTO 3: *User's Group Assignments*



This menu lists the groups to which user $ACSPJC belongs; he may have a security equivalence to other groups.

PHOTO 4: *Server Group List*



The composition of the groups in a server can be changed on either the user or the group SYSCON menu (above).

a list of internetwork servers and their specific network numbers. This menu is a likely place for Novell to integrate the management of several file servers and to make security in such a situation more homogeneous.

NetWare's security is the most complete of any currently popular LAN. The proprietary operating system and file structure used in file servers make data even more secure; even booting DOS on that server does not provide access to the data. In university applications, security has been sufficient to run an academic lab and departmental offices on the same file server. With improved auditability through limiting the role of the SUPERVISOR, keeping optional access logs of critical files, and not allowing file information to be changed, NetWare security would be comparable to mainframe security systems.

ELECTRONIC MAIL

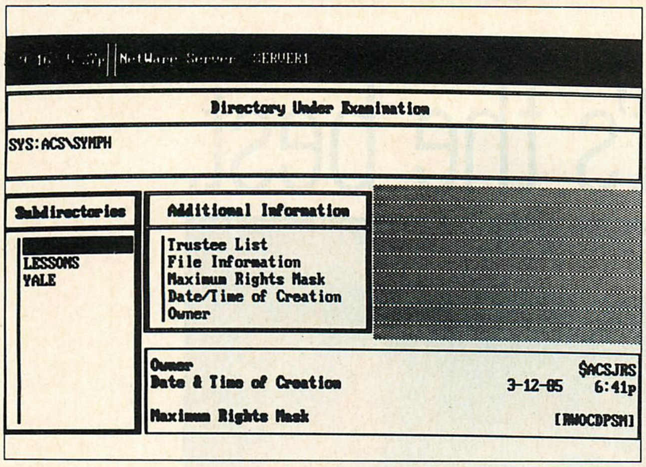
An electronic mail system is included free with NetWare and Advanced NetWare. It was once sold as a separate product. NetWare EMS is friendly, with good help screens. It uses the security system for designating receivers. Messages are created easily, but EMS is command driven and often welcomes verbose English-like commands, similar to the HELP system. The command

LIST ARCHIVED MAIL FROM ANYONE IN ACCOUNTING

gives an indication of EMS's power: it would permit the user to look at old mail, selecting it by sender or receiver user ID or group. The down side is that the command is long and cannot be abbreviated. Users can send any file as a piece of mail, even a program. This is a useful alternative to granting another user trusteeship rights to an otherwise protected file. Nevertheless, EMS lacks important features, making it difficult to use. It would be improved by some added capabilities, including:

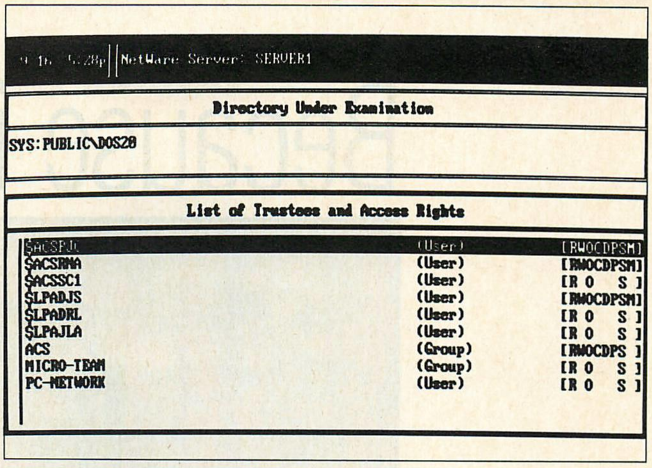
- Return receipt or some other acknowledgment of receipt
- Ability to conveniently reply to a received item without including the text of the original item
- Search of old mail by either subject or content
- Ability to print mail neatly, other than by screen or file extraction
- Integration of the mail system in a multiple server. The user currently has to run MAIL on the server where he wants to send a message.
- Access by hot-key or by a multitasking operating system, so that both mail and some other application can be handled concurrently.

PHOTO 5: *Directory Display*



The primary information displayed for a directory under examination is the owner name and maximum rights mask.

PHOTO 6: *Trustee Directory*



User rights for directory PUBLIC/DOS20 can be changed either on the trustee menu (above) or on the user menu.

NETWARE, THE PERFORMER

NetWare is strongest in the areas of security and performance. According to a Novell dealer's newsletter called *LanTimes*, Belmont Laboratories, an independent testing facility owned by Ziff-Davis Publishing Company, tested 13 LANs running both their native software and NetWare. The performance of every LAN improved when running NetWare, in both programming and DBMS applications. A sample of the results is shown in table 5.

NetWare uses three techniques to reduce the processing time of file server I/O requests: hashing of directories greatly reduces file look-up time; disk caching keeps copies of frequently accessed disk sectors in the memory of the file server, improving access time (cache size is determined dynamically by the memory available in the file server); and elevator seeking utilizes the current position of the disk head to influence the ordering of disk read-write requests, reducing seek time.

The NetWare documentation consists of a user handbook and a system guide; both are complete and professional reference manuals. The many examples are noteworthy aids in explaining, for example, the somewhat complex NetWare security options.

A third document is needed, however—a guide for the user who has been set up on the network by a supervisor and needs to understand some of the product's capabilities, but not all. The current documentation's statement that, "A User Handbook should be purchased and kept at each workstation," is true only if all users are power users who *want* to have extensive knowledge of the network. The manual also says that "The novice network user should learn the SETLOGIN command as soon as possible." Again, this is not necessary if the supervisor is doing a good job.

This suggested guide could be brief, so as not to be intimidating. It could define NetWare commands such as SPOOL and MAIL, yet not be redundant with on-line HELP. This manual could be similar to the *Disk Operating System User's Guide* included with DOS 2.0 and later, but might include a section to be completed by the supervisor describing the user's initial setup, SETLOGIN, and trusteeships, possibly by a fill-in form, initially supplied as a file on the distribution diskettes. Such a manual would help the sophisticated NetWare package to maintain its simplicity in the eyes of the user.

NetWare offers rich function, flexibility, and compatibility with major hardware and software.

Installation of NetWare is generally performed by a dealer; for the courageous, the installation and maintenance section of the system guide for Advanced NetWare is 190 pages long. Yet the process is not inherently complex. The section is lengthy because it covers many different fixed disks and PC compatibles that NetWare supports. It also offers the supervisor complete information on creating a friendly environment for users, setting up diskless workstations, reducing file server disk fragmentation, and using a file server as a workstation (explaining the many restrictions that are involved.).

NetWare provides the installer or manager of a network with an abundant set of tools that enable him to set up a sophisticated system. In addition, it offers rich function, flexibility, and compatibility with major hardware and software products. Its security is in a class by itself, and it performs at, or nearly at, the top of all industry benchmarks.

Novell's offering is clearly the LAN operating system leader for the medium-to-large office with five or more networked PCs. Its cost, in combination with the product's complexity, may prompt the smaller office to look to other vendors. Yet, NetWare should be considered if the company expects to grow significantly. A simpler guide and uniform presentation of user commands by means of pull-down or hot-key menus would make it easier to use; this currently depends solely on a properly supervised setup. Look for Novell's NetWare to exhibit a quality evolution as a product at the forefront of the LAN movement.

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Art Krumrey is director of academic computing services at Loyola University of Chicago. He has a master's degree in computer science from Northwestern University. Wiley Crawford of Kenwood Associates, in Chicago, assisted in the researching of this article.

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10	½	yes	85 msec	5 Mbits/s	$ 495	$ N/A
21	½	yes	85 msec	5 Mbits/s	$ 795	$ 595
21	Full	no	30 msec	5 Mbits/s	$ 1,535	$ 1,340
32	½	yes	85 msec	5 Mbits/s	$ 995	$ 795
32	Full	no	30 msec	5 Mbits/s	$ 1,775	$ 1,575
65	Full	no	30 msec	5 Mbits/s	$ 2,295	$ 2,070
100	Full	yes	18 msec	10 Mbits/s	$ 4,995	$ 4,995

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10	½	no	90 msec	5 Mbits/s	$ 1,095	N/A

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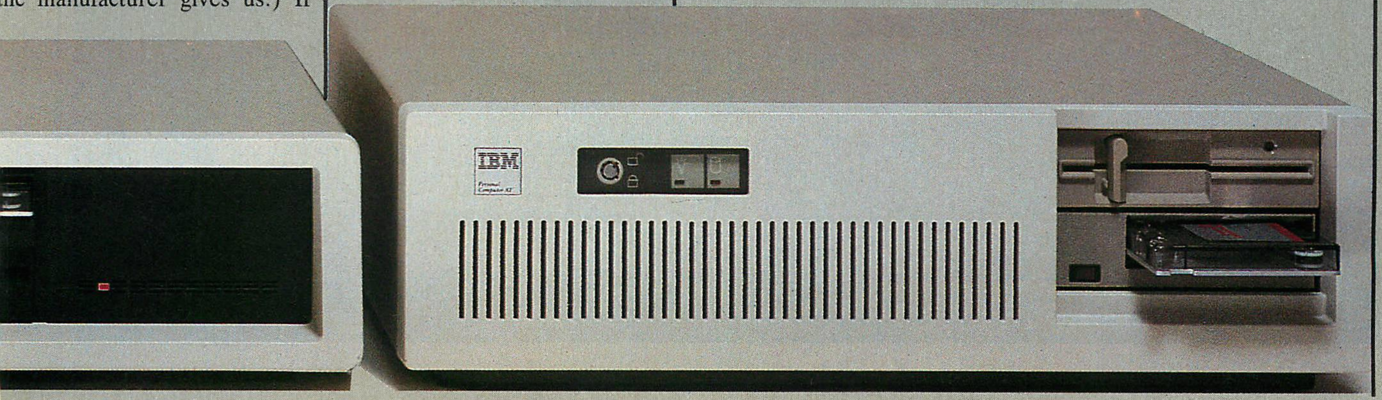

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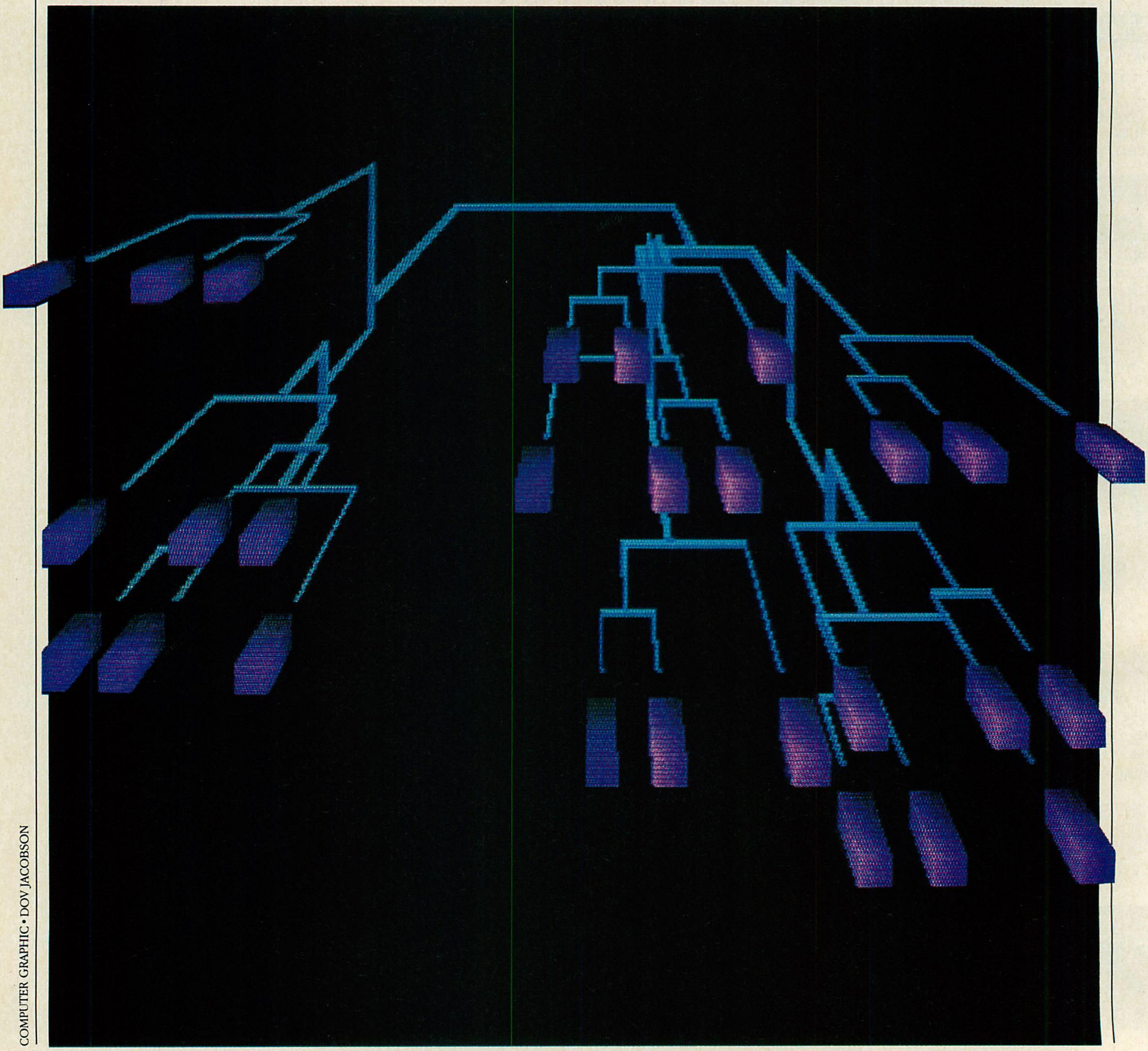
A Data Manager with Mainframe Compatibility



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Information Builders, Inc. has squeezed its mainframe data manager into a PC package; PC/FOCUS will especially appeal to those users already familiar with a mainframe environment.

WILLIAM CASEY

In the early 1970s a popular database joke made its way around computer circles. IBM's major database management product was (and still is) the Information Management System. It was a behemoth: a giant system, as complex as it was big, difficult and tedious to use even by the most experienced people. The story was that IBM, in an effort to outmaneuver the software companies and eliminate their competitive threat, was going to put IMS onto a chip, making it a part of the computer hardware itself, and any potential market for independent database software would evaporate overnight. The only problem, as the story went, was that no one had yet figured how to mount and install a 189-pound chip on a circuit board.

The years have reduced the weight of the fabled chip somewhat so that it now fits the PC. The joke now might be how to squeeze such a sprawlingly large database management system into a microcomputer. Information Builders, Inc. has attempted to do so with its own IBM mainframe data management tool, FOCUS. The micro version is PC/FOCUS, a huge chunk of program brought down body and soul from IBM mainframe-land. The guiding design principle has been to give the PC user as many of the FOCUS tools and as much of the system's overall power as possible.

The market to which PC/FOCUS addresses itself consists of two segments: sites that already have mainframe FOCUS (primarily companies in the Fortune 1000), and system integrators who use PC/FOCUS as a development engine with which to build turnkey or vertical applications. Its $1,595 price suggests PC/FOCUS is not directed at the small business or individual PC owner, although it offers very capable retrieval and report-writing facilities to users of standard microcomputer database managers, especially those with substantial production report needs. Its capabilities in these areas far exceed those of PC-only database systems such as dBASE or R:base—of course, so does the price.

A local area network version of PC/FOCUS, to be called Multiuser PC/FOCUS, has been announced for general distribution. In its initial form it will support the Nestar and IBM/Sytek networks and features, in addition to two nodes, a file server on which the user files will live, and a SYNC Machine (PC/AT or its equivalent). This setup is Information Builders' mechanism for dealing with the traditional shared access problems of concurrent update, deadly embrace, and recovery from failure. Information Builders claims that this multiuser version will include record-level lockout, a feature that is absolutely necessary for adequate performance with more than a few users accessing one database.

PC/FOCUS COMPONENTS

PC/FOCUS presents the user with a large, complex set of tools for defining, loading, and using data. With LINK, *using* includes intelligent transfer of PC/FOCUS files to and from the mainframe FOCUS environment. It is a rich system, which has considerable depth in most areas and which construes *data management* in that term's broadest sense.

Once inside PC/FOCUS, the user is able to enter various environments. In most cases, these environments can be accessed interactively or via execute files, which are stored collections of commands. Each part of the system has its own operational nuances, but shares a generally similar set of command structures. At its highest, or command level, PC/FOCUS encompasses:

A data description language. This allows users to define PC/FOCUS files that use a comprehensive set of data relationships. In addition, non-PC/FOCUS flat files (extracted files from another database system) can be defined and used in conjunction with the system's report writer.

A report definition language (TABLE subsystem). The TABLE facility permits a wide range of output formats (including DIF files or Lotus 1-2-3 format) to be described, catalogued, and generated. TABLE is implemented in such a way that it can operate as an interactive query language as well as a formal report-writing tool. As a regular report writer alone, it is without doubt the best in its class in the microcomputer world.

A modest terminal graphics subsystem (GRAPH). GRAPH supports four kinds of formats. This perhaps is best seen as an extension of the PC/FOCUS report preparation facilities. GRAPH is terminal-oriented in the sense that PC/FOCUS includes no special drivers to support graphics printers and/or plotter devices other than the HP 7475A plotter.

Two related end-user languages. These languages support statistical analysis and financial modeling and are also best considered as extensions to the PC/FOCUS report preparation subsystem rather than as separate languages. The financial modeling capability is not a spreadsheet tool, however.

SCAN. This facility supports a variety of access and update modes against PC/FOCUS files. Databases can be examined and modified (ADD, DELETE, CHANGE) one record at a time or examined in tabular format. Although PC/FOCUS has no built-in, syntax-driven query language (for example, no QUEL or SQL), SCAN provides an approximation to this kind of functionality: database records can be displayed based on

selection criteria expressed in a format such as the following:

LOCATE AUTHOR NAME CONTAINS SCI AND CITY EQ ATLANTA

A maintenance language. This permits definition of so-called modify procedures to load, retrieve, and update data. The language elements in these procedures are generally shared with those available in the report writer and elsewhere in PC/FOCUS. Extensions to the basic line-oriented and batch transaction-oriented character of modify procedures result in facilities to work with screens as a whole. These facilities are encompassed in PC/FOCUS's Interactive Entry Language (FIDEL). Related as well to modify procedures is the Dialogue Manager, a macro-substitution language that allows runtime specification of variables into stored PC/FOCUS procedures for repetitive use. The Dialogue Manager is, however, more of a superset of the modify procedure language than it is a separate entity; the result is stored dialogues containing lines of PC/FOCUS commands in addition to a structure permitting testing and runtime branching within the dialogue/super-procedure itself. Also available is a user-structured language facility. This permits database administrators or applications builders to define language elements, inventing new keywords for vertical end-user implementations or other purposes.

FOCTALK. Last, and perhaps least, is FOCTALK, a set of four front ends to PC/FOCUS. These include LINK, which allows intelligent connection with mainframe FOCUS for two-way file transfer. Both asynch and 3278/79 bisynch (via the IRMA board) are supported. FILETALK and TABLETALK are menu-driven aids that use colors and window-like sections of the screen to generate PC/FOCUS file definitions (FILETALK) and report specifications (TABLETALK). In each case, the end result of one of these sessions is a file of PC/FOCUS file definitions or report descriptors. The fourth front end is a text editor called TED. It is a variation of XEDIT, a full-screen editor available under IBM mainframe's CMS operating environment. In its favor, TED supports multiple file windows and other niceties; on the other hand, it is very mainframe-like, it borders on slowness, and it is terribly under-documented. PC/FOCUS documents no formal method for users to substitute their own editor for TED. However, the same result was achieved by establishing a function key with a value of:

DOS EDIX c:\focusdir\<1>.

All of these FOCTALK pieces claim to be based on artificial intelligence, apparently because they prompt the user to perform powerful tasks with PC/FOCUS. That is mostly a marketing ploy, however; FOCTALK is simply an adequate menu system. It does not eliminate the need for the PC/FOCUS user to learn in detail the specifics of the environment and its basic commands.

PC/FOCUS is provided on 11 floppy disks plus a red-dot activator disk that must be present in the A: drive when the system is booted. The red-dot disk is a primitive form of protection, out of place in a product as sophisticated as PC/FOCUS claims to be. The installation procedure for PC/FOCUS is merely to copy the contents of all the diskettes into a single directory of the target machine's hard disk and then to invoke the program INSTALL, all of which is completed in a few seconds.

Its $1,595 price suggests PC/FOCUS is not directed at the individual PC owner, but it offers capable retrieval and report-writing facilities to users of microcomputer database managers.

The system occupied just less than 4 million bytes of hard-disk space on the PC/XT used to test it for this article. An additional 500,000 to 1 million bytes is required for PC/FOCUS work space. For many users this means taking a careful look at the contents of their secondary storage. PC/FOCUS would fit most comfortably on a PC with at least 20MB of hard-disk storage available.

This is a resource-consumptive product. It requires a minimum of 512KB of memory to run at all (referred to as *standard mode*), but the user is encouraged, in the interest of better performance, either to run PC/FOCUS on a 640KB machine (*enhanced mode*), or to install an additional 512KB memory board available from Information Builders to bring a 256KB machine to a total of 768KB of memory (*enhanced + mode*). PC/FOCUS also will take advantage of the 8087 coprocessor chip if it is present in the user's machine.

Moving from PC/FOCUS's command level to its various designated environments, such as for reporting, graphics, and data definition, is not especially difficult. However, during testing, the system occasionally would pause, apparently awaiting a response (its prompt of > instead of >> tells the user that much), but it gave no clue about what it wanted. In most such cases, entering End (sometimes two or three times in succession) would return the system to the command level.

Procedures or subcommands that are executing are supposed to be stopped by pressing Ctrl/Break, then KX (for kill execution), but this simply does not work. Information Builders explained that PC/FOCUS is difficult to stop executing without canceling. Canceling requires two Ctrl/Breaks and returns the system to DOS, not back to where it was before execution was cancelled.

A command-level line entered in error can only be corrected by retyping the entire line, and the last command issued cannot be repeated at the command level. PC/FOCUS supports typing ahead at the command level, but some of the subsystems (SCAN, TED) do not.

One attractive feature of PC/FOCUS command level is that a line entered in the form "DOS dos command" provides the user with access to nearly all of the normal DOS operations. This is useful for copying, renaming, and directory requests, and it is certainly preferable to systems that use pseudo-DOS commands, each of which has extra syntax that many users might find difficult to remember. In addition, with this facility some programs (EDIX, MultiMate, and Lotus 1-2-3, for example) can be run directly under PC/FOCUS.

DOS 2.0 file path names are not supported, even in the recent release of PC/FOCUS. A very mainframe-like FILEDEF command allows assignment of logical data file names to particular physical files (each can have differing drive assignments), but the user must have the current directory set at the correct level for the drive when the system endeavors to open a data set.

PC/FOCUS has no print drivers and no way to send control codes to the printer for changing font size or color. Only LPT1 is supported.

PC function keys are user-assignable at the command level in PC/FOCUS. The statement "LET !n = ..." makes the designated key equivalent to a line of text. These function commands also can contain embedded variables with values for which the system will prompt at execution time. A file named PROFILE.

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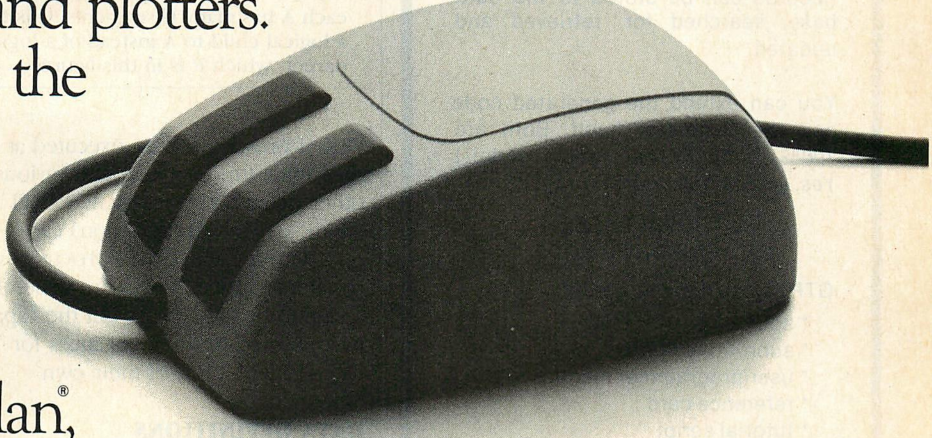

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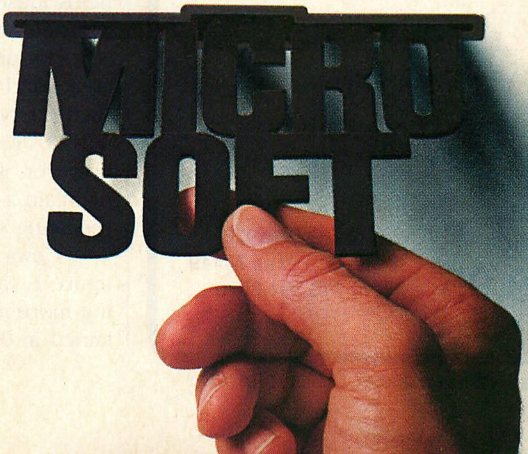

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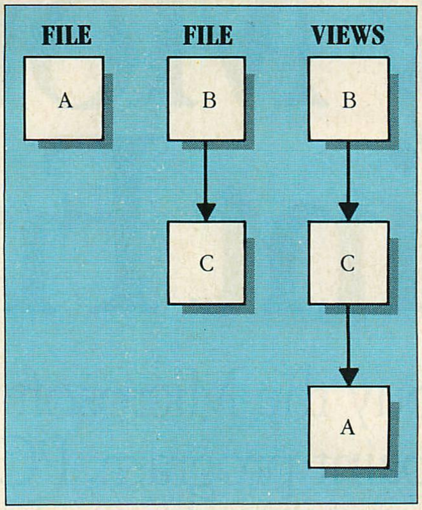
FIGURE 1: *Data Hierarchies*



Each C segment has a key value referring to one A. A view can be described to PC/FOCUS encompassing all three segments: those fields in segments B and C plus an attached virtual segment A. This technique also works if each A has many C segments. C is then a logical child to A instead of a logical parent, which it is in this figure.

FEX, if present, will be executed at sign-on so that function keys and various other defaults (LINES/PAGE, PANEL width, screen PAUSE option) can be set.

Within each of the PC/FOCUS environments, function keys are generally assigned by the system, but the capacity is supported in some instances for users to add a few of their own.

DATA DEFINITIONS

PC/FOCUS is driven from an hierarchical data model; relationships are predefined at design time, and data are viewed according to a tree-structured hierarchy, much like IBM's mainframe IMS. Databases also can be designed to include network structures.

The basic aggregate of PC/FOCUS data is the *segment*, consisting of one or more field definitions. Every segment except for limited-use cases must have a designated key or set of keys, and these fields must appear first in the segment. Key fields are by definition indexed in PC/FOCUS, and the user is not free to create and eliminate indexes on-line; such operations must be done with the PC/FOCUS restructure utility. Within a file, however, it is possible to establish and maintain a hierarchical structure of repeating segments.

Views of the database, as shown in figure 1, can be described encompassing more than the single hierarchy contained in one file. In other words, logical relationships can be established linking more than one physical database. These relationships are maintained by PC/FOCUS for the user. Cross-file references are established on the basis of a key and the target segment in the corresponding database must be indexed on the redundant field. Indexes also are updated automatically by PC/FOCUS at all times. Database views can be turned upside down in the sense that what normally would be a dependent segment becomes—in a specific view—a top-level or root segment, and all other logically connected segments appear subordinate to it.

PC/FOCUS is capable of describing and supporting many levels of repeating groups—long anathema to relational data models. It also establishes predefined relationships only between indexed fields—equally unrelational. How, then, can Information Builders claim that its product is a fully relational system? It gives this directive: do not define files with more than a single segment and use the PC/FOCUS JOIN command to combine files at query and/or report preparation time. While this is technically accurate, the JOIN function actually is a weak command that combines only whole files of data (no WHERE or FOR clauses as in Ingres, Oracle, or even dBASE) and has its own set of indexing and other prerequisites.

Even though the term *master dictionary* emerges repeatedly in the *User's Manual*, PC/FOCUS lacks a centrally maintained set of definitions. Instead, each file is defined by means of a series of file, segment, and field descriptors that must be present in a file called filename.MAS. Data corresponding to the description are in a separate file and the system can be directed to different physical files, each with a common .MAS description.

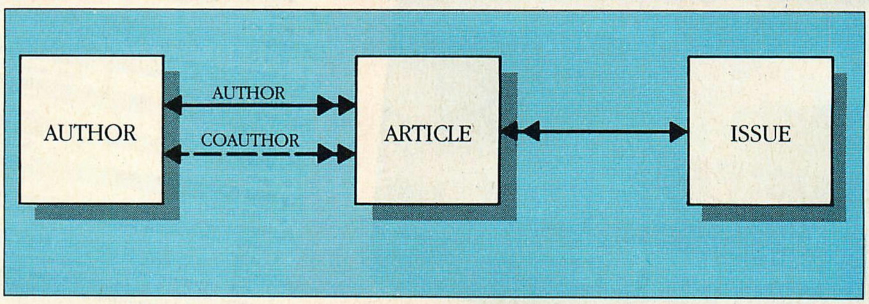
Figure 2 shows the file definition statements used to describe the Author segment of the sample editorial database developed by *PC Tech Journal* to evaluate database managers. (For a complete explanation of the sample application, see "Sample Application Specifications," August 1985, p. 48, or download it from PCTECHline.) Note that the file (AUTFILE) is defined with only a single segment (AUTHOR), so that repeating groups are avoided. This is true with all three files described in the sample database. SEGTYPE=S1 states that the file is to be sequenced on its first field; this will be an ascending key (default, but descending sequence is supported also) and will be indexed as well. Aliases are optional and, for con-

FIGURE 2: *Author File Definition*

```
FILENAME=AUTFILE,SUFFIX=FOC
SEGNAME=AUTHOR,SEGTYPE=S1
FIELDNAME=AUTHOR_NAME,ALIAS=AUTH NAME,FORMAT=A30,FIELDTYPE=I,$
FIELDNAME=ADDRESS,ALIAS=,FORMAT=A20,$
FIELDNAME=CITY,ALIAS=,FORMAT=A16,$
FIELDNAME=STATE,ALIAS=,FORMAT=A2,FIELDTYPE=I ,$
FIELDNAME=ZIPCODE,ALIAS=ZIP,FORMAT=A5,$
FIELDNAME=WORK_PHONE,ALIAS=BUS_PHONE,FORMAT=A10,$
FIELDNAME=HOME_PHONE,ALIAS=,FORMAT=A10,$
FIELDNAME=SSN,ALIAS=SOC_SEC_NBR,FORMAT=A9,$
FIELDNAME=BIOGRAPHY,ALIAS=BIO,FORMAT=A200,$
```

The author file is defined with a single segment, no repeating groups. Then each field is given a name and a type; an alias may or may not be assigned.

FIGURE 3: *Sample Database Design*



One author owns zero or more articles. One issue also owns zero or more articles. Each article, on the other hand, is owned by one and only one author and one and only one issue. The coauthor relationship has not been statically declared. If it were, it would be similar to the author relationship, except that an article could be owned by zero or more coauthors (author file occurrences).

venience, can be referenced instead of a field's name. Field names and aliases can be up to 12 characters long.

Describing a field's usage (FORMAT) to PC/FOCUS involves specifying a type and length, as well as edit options. Data types include integer, floating point, double precision floating point, packed decimal, and alphanumeric fields up to the usual 256 bytes in length. Date data types are not supported directly, although a variety of edit formats and functions allows general manipulation (including date arithmetic) and editing of dates. Free-form text and logical field types are not supported in PC/FOCUS. Edit options permit a default display format for a field to be determined, although this can be overridden at output time.

PC/FOCUS requires comma/dollar signs (,$) at the end of each line. Users who enjoy coding macro statements on IBM mainframes may enjoy the PC/FOCUS data definition language and its syntax.

PC/FOCUS contains a single REBUILD utility that is used for unloading and reloading data from existing files. Execution of REBUILD is necessary to make virtually any physical change to a PC/FOCUS database involving a change in field length, usage, or displacement. It also handles indexing of additional fields and similar arcane jobs. This utility also is supposed to be capable of diagnosing damaged files and will try to relink segments in such cases.

The bottom line on PC/FOCUS file definition relates to its considerable data modeling power; PC/FOCUS is architecturally capable of handling larger, production-scale applications. As with any database system, however, what PC/FOCUS gives the user in structuring power, it takes back in substantially lessened runtime flexibility. Furthermore, it is complicated and many of the instructions are hard to understand.

SAMPLE APPLICATION

Putting a real application into actual operation is the best way to uncover a data manager's limitations and capabilities. At data description time, three PC/FOCUS files were set up, each with one segment corresponding to the layout in the benchmark's specifications: author, issue, and article. This structure is diagrammed in figure 3. Because a one-to-many relationship existed between issue and article (one issue has many articles, any article can appear in one and only one issue), the volume and issue fields carried in the article segment

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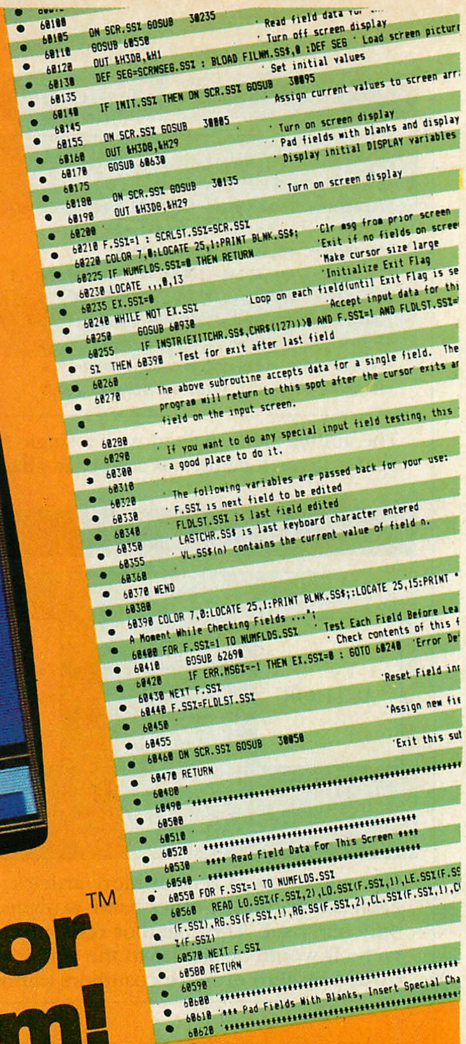

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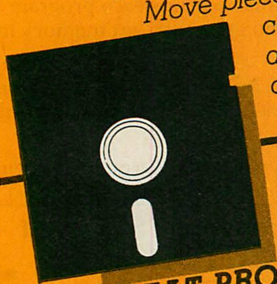

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were used to create a linkage to the appropriate issue.

The same one-to-many relationship is basically true from author to article as well. One author can own zero or more articles. However, presence of a coauthor field indicates that one article can be owned by two authors. Presence of the author name (first and last are separate) in the Article segment directly indicates the proper author; similarly, presence of a coauthor field value indicates the proper coauthor. Both author and coauthor, of course, are entries in the Author file.

An initial stumbling block occurred when the files were loaded. As input, each file's contents were in delimited ASCII format (data fields separated by commas and surrounded by double quotes). Although PC/FOCUS accepts input in a variety of free-form formats, it could not handle this layout. The requirement that each line of input be terminated with a comma/dollar sign sequence (,$) could be met with the help of global replace capabilities in the text editor. However, the double quotes were a source of difficulty; PC/FOCUS always insisted on including them as part of the field values.

In light of this problem and other formatting concerns with specific fields, the file was loaded to a dBASE III database and then extracted from dBASE to a fixed-format (SDF) file that corresponded to the PC/FOCUS file definition. This file in turn was defined to a simple modify procedure. PC/FOCUS has no LOAD, APPEND FROM, or similar command, so a user-written procedure is necessary to build a new file. This entire process was tedious and was repeated for all three files before the discovery was made that relationships could not be established dynamically between these files using the JOIN operator. PC/FOCUS requires that the key in one of the two files to be joined is a single, indexed field. Both owner keys (volume, issue number; author last name, author first name) involved dual keys, so JOIN did not work properly. In addition, PC/FOCUS's unique-key requirement meant that it rejected most article input because many articles share a common volume/issue number.

As a result, volume and issue number had to be combined into a single key in both the Issue and Article segments and author last and first names had to be concatenated into a single author name key in both the Author and Article segments. In the Article segment, a concatenated coauthor name field, coat_name, had to be created. Also nec-

essary was an article-key field to make each article occurrence unique. An arbitrary four-digit key was chosen and numbered starting at 1001.

Use of predefined relationships (article is owned by author and by issue, for example) was chosen for simplicity. The coauthor/author relationship was unspecified so that the JOIN command could be exercised at report time.

After the structure was redefined in this manner, the PC/FOCUS file layout validation procedure (CHECK FILE ARTICLE) was run to ensure its consistency, and at the same time a somewhat primitive logical picture of the file was requested (see figure 4), which contained both real and virtual fields. Virtual fields appear to be in the article record but are actually in one of its two declared owners (issue and author).

PC/FOCUS uses a B-tree structure for its physical space management. The Author file as loaded had 900 records, but each 200-byte biography field was empty at initialization time. The fixed-length SDF file written from dBASE occupied 273,920 bytes. After being loaded as Author segments in the PC/FOCUS AUTFILE, the number of bytes increased to 380,928, about 140 percent of the raw file size. PC/FOCUS does not reclaim any data space as records are deleted; the user must execute a REBUILD/UNLOAD/RELOAD using the restructure utility.

FIGURE 4: *Database Structure*

```
          ARTICLE
 01       S1
**************
*ART_KEY     **I
*VOL_ISSUE   **
*CATEGORY    **
*DEPARTMENT  **
*            **
***************
 **************
       +-----------------+
       I                 I
       I AUTHOR          I ISSUE
 02    I KU         03   I KU
..............    ..............
:AUTHOR_NAME :K   :VOL_ISSUE   :K
:ADDRESS     :    :DEADLINE    :
:CITY        :    :ISS_MONTH   :
:STATE       :    :ISS_YEAR    :
:            :    :            :
:............:    :............:
        AUTFILE          ISSFILE
```

After defining file structures, the file layout validation procedure can check consistency to produce a picture with the real and virtual fields.

LANGUAGE ELEMENTS

The PC/FOCUS processing language, which is actually a collection of sublanguages tied together in the sense that they share a set of general syntactical elements, is probably the product's most vulnerable component. What might well have begun as a straightforward, high-level, and powerful report-writer command set has become swollen beyond belief. It has a facility for handling batch transactions, components to process line-by-line terminal input (remember, PC/FOCUS was born on the mainframe), and full-screen functions for database maintenance and applications building; none is very good and all have unexpected nuances, many of which are not spelled out clearly in the documentation. However, the language does have powerful and attractive features, particularly in data validation.

PC/FOCUS is very sensitive to context; certain subcommands can be used only in certain places. For example, ON INVALID COMPUTE is not allowable but ON INVALID GOTO is. Users will find themselves frequently consulting the manual, not just trying to find which commands to use, but also to see how they are properly put together.

The basic language component in PC/FOCUS is the so-called *modify transaction*, a series of commands that can be used to add, modify, delete, or retrieve data from a designated file view. These are also known as FOCEXECs and always wear a suffix of .FEX when stored. Such transactions might be written to process an existing file of transactions, to handle terminal input that the user enters, or to drive screen-based applications processing systems. In the true mainframe tradition, all user source code that makes up the modify transaction itself must be uppercase.

Modify procedures can be compiled into a prepared and preinterpreted module. This is an asset, offering users runtime savings on larger FOCEXECs. Compilation with two on-line update procedures resulted in surprisingly large object modules. The *User's Manual* states that a compiled version of an .FEX file may be "three to five times the size of the original FOCEXEC." In one case the compiled FOCEXEC was 17 times larger than the source (28,686 from 1,632) and in the other, 24 times. While these two procedures did not run a great deal faster, larger routines might show a more discernible improvement in performance.

PC/FOCUS's processing philosophy is predicated on matching, for example, some inputted key against a designated file/segment key. Flow of control also can be affected by commands, such as CASE/ENDCASE, GOTO case name, ON INVALID, and NEXT. The PC/FOCUS language has no iterative DO WHILE structure, and the inability to nest cases would be likely to pose problems in more complex applications. Accordingly, the result of an IF statement in PC/FOCUS is exclusively a GOTO case name; there is little flexibility here.

The COMPUTE command allows the calculation of any local variables that may be required in a routine. A related VALIDATE function permits tests of data input fields, but has an unusual format in which the test itself is assigned a variable name. For example,

GOODDATE = IF (COMMISSIONED EQ 'T' OR 'F') THEN 1 ELSE 0 ;

tests a field COMMISSIONED for two values. The THEN 1 sets a test condition within PC/FOCUS to indicate a valid value; the ELSE 0 means that the system will consider the test to have failed and will reject the transaction. The user can display a message when a test shows up invalid, or he can let the system generate its own. The report writer uses an identical mode of expression to set data fields to various values. The identical form is not limited to these expressions—almost all of the language elements are the same.

Figure 5 shows the complete FOCEXEC procedure to add new article entries to the sample editorial database. This fullscreen procedure specifies a format by statements following the CRTFORM declaration. (A variation of this FOCEXEC could be written that would proceed in a line-oriented manner, using PROMPT and TYPE statements. Much of the documentation is written from this perspective, even though the need for line-by-line transaction handling on the PC is marginal.)

ON MATCH or ON NOMATCH often must be repeated on successive lines in a FOCEXEC procedure. In some cases a statement can be continued for several lines; in others, information must be repeated on each line.

The second COMPUTE (ON MATCH) in the FOCEXEC shown in figure 5 takes local variables (defined in the initial COMPUTE at the top of the procedure) and assigns them values so they can be used below. Establishing the variable WDATE RECD (using the PC/FOCUS function DAMDY, which is one of approximately 15 date-related subroutines) creates a numeric field reflecting the numbers of days since 01/01/00 for the user-entered date. This field will be 0 if the date entered is not valid.

FIGURE 5: *FOCEXEC Procedure*

```
MODIFY FILE ARTFILE
COMPUTE
 NAME_LAST/A18 = ;
 NAME_FIRST/A12 = ;
 COAT_LAST/A18 = ;
 COAT_FIRST/A12 = ;
CRTFORM
 " ADD A NEW ARTICLE -->     "
 "</2"
 "     ARTICLE KEY: <ART_KEY>"
 "  VOLUME & ISSUE: <VOL_ISSUE> "
 "        CATEGORY: <CATEGORY> "
 "      DEPARTMENT: <DEPARTMENT>"
 "           TITLE: <TITLE>"
 "AUTHOR LAST NAME: <NAME_LAST>"
 " AUTHOR 1ST NAME: <NAME_FIRST>"
 "COAUT. LAST NAME: <COAT_LAST>"
 "COAUTH. 1ST NAME: <COAT_FIRST>"
 "    COMMISSIONED: <COMMISSIONED>"
 "   DATE RECEIVED: <DATE_RECD>"
 " EDITORIAL PAGES: <EDIT_PAGES> "
 "   LISTING PAGES: <LIST_PAGES> "
 "         PAYMENT: <PAYMENT> "
 "           BONUS: <BONUS>  "
  MATCH ART_KEY
  ON MATCH TYPE "ARTICLE <ART_KEY> IS ALREADY IN DATABASE"
  ON MATCH REJECT
  ON NOMATCH COMPUTE
   AUTHOR_NAME/A30 = NAME_LAST|NAME_FIRST ;
   COAT_NAME/A30 = COAT_LAST|COAT_FIRST ;
   WDATE_RECD/I9 = DAMDY(DATE_RECD,WDATE_RECD) ;
  ON NOMATCH VALIDATE
   VITEST=FIND(VOL_ISSUE IN ISSFILE);
   OKCAT=DECODE CATEGORY ('PRODUCT REVIEW' 1 'TECHNICAL ARTICLE' 1
         DEPARTMENT  1 'TECH NOTEBOOK' 1 ELSE 0) ;
   OKDEPT=IF (CATEGORY EQ 'DEPARTMENT') THEN
         IF (DEPARTMENT EQ 'PROGRAMMING PRACTICES' OR 'DIRECTIONS'
            OR 'LEGAL BRIEF' OR 'PRODUCT OF THE MONTH') THEN 1 ELSE 0
         ELSE IF (DEPARTMENT NE ' ') THEN 0 ELSE 1 ;
   OKTITLE=TITLE NE ' ' ;
   OKAUT=FIND(AUTHOR_NAME IN AUTFILE) ;
   OKCOMM=COMMISSIONED EQ 'T' OR 'F' ;
   OKRECD=WDATE_RECD NE 0 ;
   OKBONUS=BONUS GT 4.99 AND BONUS LT 20.01 ;
 ON NOMATCH INCLUDE
CASE BADCAT
 TYPE "CATEGORY <CATEGORY> IS NOT LEGAL"
ENDCASE
DATA
```

These commands allow articles to be added to the sample editorial database. This procedure specifies a format by statements following the CRTFORM declaration.

The VALIDATE subcommand is nice to use when writing code in PC/FOCUS. Each test is assigned a name that can be in one of these forms:

- a direct compare (TITLE NE ' ');
- a built-in table look-up—DECODE CATEGORY ('PRODUCT REVIEW'...); DECODE also can direct the system to another PC/FOCUS file of values;
- a cross-file validation that can draw on any indexed field in any file—FIND (VOL ISSUE IN ISSFILE).

CRTFORM also supports extended screen attributes, such as color, blinking, and high intensity, although they are not part of the example here. FOCEXEC procedures can be much more complex than this simple routine, but the example conveys an idea of what the language looks like.

Multiple files can be updated in a single FOCEXEC after a COMBINE command has declared them to be available. When the COMBINE capability is used, however, all data names must be unique across the files involved. In working with an application of substantial size, this seems a bit restrictive.

Debugging is a mundane operation with PC/FOCUS procedures. The interpreter stops and tries to describe the problem, indicating the number of the source line with the problem. Beyond this, the product's debugging facility is not especially noteworthy. A procedure cannot be stopped in the middle of execution, and the values of locally defined variables cannot be displayed. In building a complex application this could represent a serious shortcoming.

Altogether missing from the PC/FOCUS language is a numeric check, a process that can ensure whether or not a field defined as alphanumeric actually contains numbers. This is not an unusual requirement, but PC/FOCUS does not support it. Neither can the beep be sounded on the PC, nor can applications procedures be linked to a help screen subsystem. At the command level, the user is able to add help files in the form, keyword.ERR, but this does not prove especially valuable to the user of an applications system.

User-written functions are not permitted as they are on mainframe FOCUS. Although in the Dialogue Manager language FOCEXECs can be executed with control returning to the caller, a general inter-FOCEXEC transfer of control—with or without a passed parameter list—is not supported. Field concatenation is supported directly.

SCAN FACILITY

Generalized interactive access to PC/FOCUS database files is available through the SCAN environment. SCAN combines overall power and admirable flexibility with some surprising—and in some cases crippling—limitations.

When issued from the PC/FOCUS command level, SCAN FILE ARTFILE would put the user into SCAN mode using the article view of the database. All connected segments and their fields are available (in this instance, this would include all fields for the corresponding author for any article, as well as all fields in the appropriate issue).

Once inside SCAN, the user can select one of two display formats. These can be switched at any time and each of them allows the user to specify which fields are to be displayed from all those available in the subject file(s). In what Information Builders calls *normal display*, fields are displayed in columnar format, with field names or aliases at the top of the screen and data values for individual record occurrences (rows of a relational table) listed down the screen. In this relational display format, the screen can be scrolled left and right to show fields outside of the screen's frame. This form is for browsing only; update of data is not permitted.

CRTFORM displays the selected records one at a time on the screen and allows data in a given record to be modified. In either mode, records can be displayed on the basis of a NEXT *n* (relative to current position in the file) or of tests; for example:

```
LOCATE CITY EQ 'TERRE HAUTE'; LOCATE
    AUTHOR NAME CONTAINS 'SCIABICA'
```

Fields do not necessarily need to be indexed in order to be the object of LOCATE subcommands in SCAN.

As with other PC/FOCUS components, SCAN may require some syntactical contortions. If the user wants to see all records corresponding to a condition, SCAN requires the seemingly ubiquitous comma/dollar sign (,$) followed by an asterisk at the end of the LOCATE statement. This would be humorous if it were not, in fact, true.

```
LOCATE ZIPCODE EQ '10020' ,$ *
```

This is all implemented in a rather elaborate fashion. For example, in CRTFORM, the user can modify real data fields (but not virtual fields—those in logically connected segments from other files), only by going to the bottom of the screen and issuing a REPLACE or REPLACE KEY command to change a key field. This is awkward and time-consuming, especially when compared to dBASE's browse mode. Segment occurrences also can be DELETED in CRTFORM display. If the user opts for

INPUT mode within SCAN, a specially reserved portion of the screen can be used to create new records.

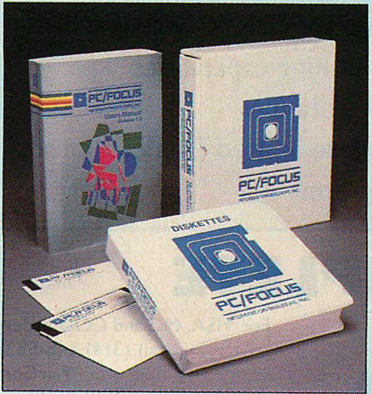
SCAN's most serious limitation is its ability to speak only in uppercase, a mainframe influence. The user cannot search for any lowercase characters. This is a hindrance because microcomputer databases are likely to be mixed upper- and lowercase. Another operational inconvenience of SCAN is that field widths cannot be reduced when they are selected for display via the SHOW or CRTFORM statements.

The SCAN facility also suffers from a slight tendency to hang the machine. This happened twice during the testing process for this article; the system got "stuck" in SCAN mode while using PC/FOCUS, and the machine had to be rebooted each time.

PC/FOCUS OVERVIEW

PC/FOCUS, version 1.5
Infobuild, Inc., 150 York Street, Suite 1313, Toronto, ON M5H 3S5; 416/364-2760.

Product type. Multifunction product with database management system, financial modeling, screen manager, text editor, graphics, asynchronous communications, and micro-to-mainframe link.
Software environment. PC-DOS 2.x, 3.x.
Network support. Nestar.
Hardware environment. IBM PC, PC/XT, PC/AT, and IBM compatibles with a minimum of 512KB of RAM and a 10MB hard-disk drive. Also supported are additional RAM, modem, and 8087 coprocessor.
User interface. Program is menu-driven and uses macros/procedures. The command language, data definition and manipulation are English-like.
File limitations. 255 characters per field; 4,096 characters per record; 250 fields per record; unlimited records per file; 16 open files; unlimited indexes per file. The program allows a file to span multiple disk-volumes. Uses relational, hierarchical, networked, and free-form data dictionary architectures.
Access to system facilities. From within the program the user can display a directory of files on a disk, create and change subdirectories, delete, rename, and copy files, check file size, and check available disk space.
File modification facilities. The program can merge two or more files into a single file, update a file with data from another file, and update multiple files simultaneously. The user can add fields without losing data in the file.
Help facilities. On-line help is provided.
File design. The program allows custom data-entry screens. The user may create multiple screens for a single file, each of which may be more than one screen in length. Program supports derived fields using information resulting from calculations, another file, or a user-supplied list or file of acceptable values. Other field attributes allow for view-only fields, numeric fields, user-defined numeric formats, must-enter fields, and double-entry fields that force the operator to reenter information to verify accuracy.



Data entry. The program automatically checks for duplicate entries in a file; provides range checking functions; allows the user to supply standard entry values during entry; and provides facilities for batch data entry.
Query and sorting. Search facilities allow for partial key search, phonetic searches, selection operators, and logical operators. Sorts may be performed in ascending and descending order. The product supports multiple sort operations on up to 32 fields and multiple indexes on all fields. Query and ordering specifications may be saved for repeated use. The program supports automatic updating of indexes.
Reporting. Report formats may be edited and may contain information from two or more files. The program produces summary reports that may include totals and subtotals, control breaks for pagination, and calculated results using four-function math, parenthetical control of order of operations, averages, and statistical functions. Final reports may include headings, footers, and pagination. Reports may be directed to the screen, printer, a disk file, or an import/export file. Users may specify paper size and margins in the report definition.
Security. The program provides password-protected access to the program itself and to program fields. Multiple levels of password protection and data encryption facilities are provided.
Utilities. File maintenance, backup utilities, print-outs of reports, and file-design definitions.
Applications development facilities. Customization is possible with macros/procedures and custom menu generation. The program provides programmable procedural language and generates turnkey applications. A runtime compiler or module can be used with applications developed.
Data compatibility. Integrated product allows data exchange from data manager to graphics and from data manager to report writer. The program reads fixed length ASCII file formats, and writes DIF, Lotus, and fixed length ASCII file formats.
Special features. Graphics capabilities supported by the program include connected point, histogram, bar charts, and scatter diagrams. A Financial Modeling Language is also supported, and, through the micro-to-mainframe link, users have access to any data available on the mainframe version of the program.
Delivery. Began in June 1983; current version first delivered in June 1985.
Distribution. Primarily through direct sales, OEMs, and resellers.
Price. Retail: $1,595.
Support. The product includes on-screen tutorials, telephone support, demonstration disk, updates, and end-user training. A support service contract is available for $275 per year. The product is copy-protected.

This material is taken from Data Decisions Microcomputers, *a three-volume monthly updated reference service that evaluates microcomputer systems, software, and peripheral products. For additional information, contact Data Decisions, 20 Brace Road, Cherry Hill, NJ 08034. 609/429-7100.*

REPORT WRITING

The report-writing facility in PC/FOCUS is the nucleus around which most of the system has been constructed. The PC/FOCUS *User's Manual* begins with a 233-page section on the TABLE subsystem, which is the real heart and soul of PC/FOCUS as a system. TABLE is not simply a built-in LIST subfunction; it is also an output processor, accepting as input PC/FOCUS database files or PC/FOCUS-described external files and producing rudimentary columnar lists as well as very sophisticated print or nonprint output.

TABLE's ability to serve effectively as both report writer and query facility is made possible by its handling of output from user-inititated retrieval operations. These are always placed in a table to which the user has considerable power of access. The user is able to scroll around this output, search for character strings in it, RETYPE it to a printer, and SAVE some or all of it in a file. These output facilities are convenient, generally work as described in the manual, and supply a high degree of flexibility in using the system.

TABLE deals with PC/FOCUS views described in the dictionary files (.MAS descriptor) corresponding to a named file (for example, TABLE FILE ISSFILE); this is simply a matter of seeing the input data as a flat file. In highly structured environments, PC/FOCUS returns to the user dependent segment occurrences in their turn, while owner (parent) information stays fixed. TABLE is straightforward and easy to use; its only limitation involves the predefined cross references that PC/FOCUS is forced to follow at access time.

Although not formally part of TABLE, PC/FOCUS's JOIN command is most useful in the report environment. In PC/FOCUS, files designed as simple two-dimensional (relational) tables can be combined dynamically through JOIN, producing a third file. The object data item in the second file must be a single field and must be indexed. The third file is a logical view encompassing all fields from both source files (no projection) as well as all rows (no selection); it also can be used as a source file for another JOIN command. Recursive JOINs (same file to itself, a requirement in any kind of nested or bill-of-materials-type relationship) are supported, albeit somewhat awkwardly. Up to 16 files may be JOINed at one time. Although this may not be what E.F. Codd had in mind 15 years go when he first proposed the relational data model, JOIN is a weak implementation of se-

FIGURE 6: *Matrix Report*

```
Report Commands:
----------------

SET WIDTH=130
SET PANEL=160
TABLE FILE ARTFILE
 " "
 "MATRIX REPORT "
 " "
 COUNT ENTRIES AND ROW-TOTAL AND COLUMN-TOTAL BY
   CATEGORY ACROSS ISS_YEAR
END

Report Results:
---------------

PAGE     1

MATRIX REPORT

                          ISS_YEAR
                          1985   1986   1987   TOTAL
CATEGORY
----------------------------------------------------
Department                  48     48     48     144
Product Review              12     12     12      36
Tech Notebook               24     24     24      72
Technical Article           36     36     36     108

TOTAL                      120    120    120     360
```

Complex reports can be generated with a powerful set of commands. The few commands at the top generate the matrix report at the bottom.

lected relational features and functions as an architectural add-in to PC/FOCUS.

All ordering and formatting is internal to TABLE, as it should be in any output processor. Therefore, the user does not need to sequence any data prior to entering the environment. The power of sorting in TABLE has great depth: as many as 32 sort keys can be designated and can include calculated as well as input data fields.

In addition, PC/FOCUS offers several options that are unusual in nonmainframe systems. These include left-to-right sorting (for matrix page display formats), descending keys, display of only the HIGHEST or LOWEST entries, and built-in support for sorting on the highest/lowest or IN-GROUPS-OF when dealing with numeric fields.

PC/FOCUS has broad support of matrix-type reports. Besides horizontal sorting, both row and column totals may be requested. Figure 6 shows the source and result of such a report.

Other basic components for report specification include the following: a LIST or PRINT field name allows specified fields to be displayed (LIST adds a report line number for reference); SUM and COUNT verbs permit effortless specification of nondetail displays; IF

allows any field to be tested and compound conditions stipulated; besides the usual operators (EQ NE, GT, etc.), FROM, CONTAINS, INCLUDES, OMITS, and masked compares are available; built-in functions allow maximums, averages, first value retrieved, percentages, and other values that can be named in the report specification.

A PC/FOCUS report/query request can be as simple as:

TABLE FILE AUTFILE COUNT AUTHOR
NAME BY STATE RUN

These statements can be entered interactively or stored as FOCEXEC files. In the case of stored reports, Dialogue Manager allows runtime substitution of selection or other parameters.

Virtually total control is available over placement of data fields on the printed page. Multiple line formats can be described (field name OVER field name) and columnar positions assigned (absolute or relative) as needed. Other formatting capabilities include edit masking, line-folding, concatenation, and a DECODE facility to display descriptions corresponding to codes. In addition, PC/FOCUS recognizes both REPORT and PAGE headers and footers. The user can specify seven kinds of page headings (such as column titles, subtotal lines, recap lines).

Control over subtotaling options is also provided. PAGE-BREAKs and SKIP-LINEs can be named; fields can be COMPUTED, SUMMARIZED, or RE-CAPPED, to name some of the operations that are available.

File export from PC/FOCUS is provided through the TABLE environment. Outputs can be saved as fixed-format, Lotus 1-2-3, or DIF files.

Shortcomings of the TABLE facility are minimal compared to its overriding power. One complaint that might be made concerns the syntax, which is not as consistent as it might be, is full of little notations and codes, and never makes clear when to use double or single quotes. Another problem is that for simple editing, a local variable often has to be established, including simple truncation (print only 30 characters of this 40-character field), and date, phone number, and other mask-type formats. The PRINT specification could handle these formatting needs much more conveniently. These criticisms aside, PC/FOCUS's TABLE subsystem is a very capable piece of retrieval software.

AT LEAST ADEQUATE

In absolute terms, PC/FOCUS performance was adequate, as the benchmark results in table 1 show. For a system that consumes a great deal of available resources (memory, disk space), it did some of its larger jobs with alacrity. Loading 900 Author file records from a fixed-form flat file took only 107 seconds—at least as fast as any of the three systems *PC Tech Journal* has tested so far. Building an additional index on that same file required only a modest 21 seconds, and producing a matrix count of authors by state (a task for which PC/FOCUS would appear to be well-suited) was an 11-second operation. Writing out a flat file from PC/FOCUS made up of authors from California sorted in zip-code sequence took 10 seconds—somewhat longer than the other products tested.

In spite of these good benchmark results, PC/FOCUS suffers from an overall sluggishness. A noticeable source of annoyance is the habit of FOCEXEC files to take their time starting up. Lack of type-ahead capability in SCAN and TED contributes to a feeling of slowness in both of these subsystems, even though they actually are not that slow.

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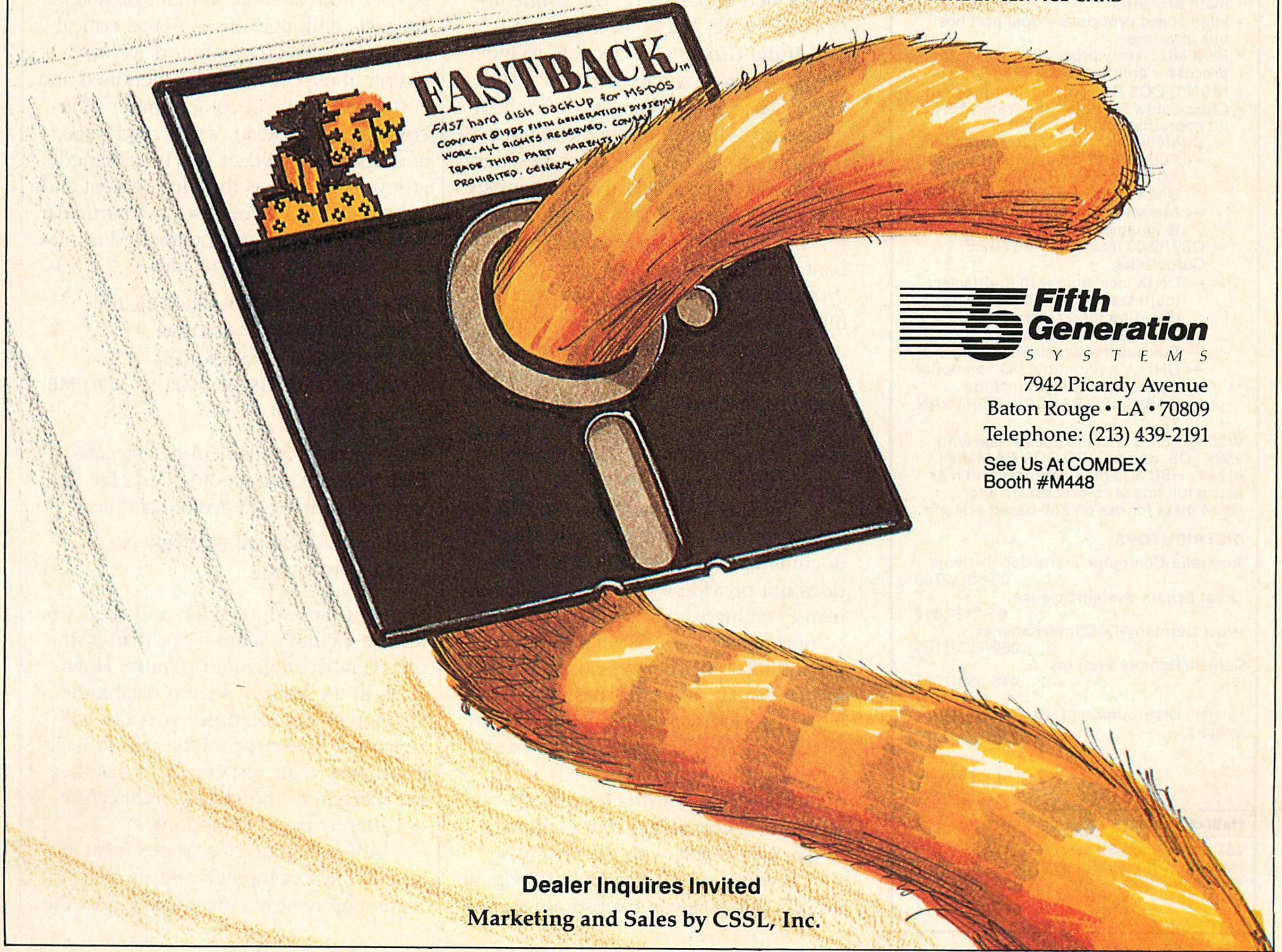

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TABLE 1: *Benchmark Results*

BENCHMARK TASK	TIME (secs)
Add 900 records to an empty database	107
Index database on two fields (7 bytes)	21
Document and tally codes from one field	11
Mass change of one field (28 records of 900)	17
Extract selected records to create a text file	10

Despite the fact that PC/FOCUS is a system that is pretty heavy on resource use (memory, disk space), it did some of its larger jobs with alacrity.

PC/FOCUS performance in the documentation department is perhaps a little less than adequate. The *Guide to Operations* is a thin, loose-leaf binder, sufficient to get the system installed and introduce a few of the basic system components. The introductory section, "Getting Started," is a primer that does not go far enough. The *Guide* contains no discussion of what the entire system seeks to accomplish or of its methods for approaching data management. Many system components, including SCAN, FIDEL, graphics, and statistical analysis, are not discussed at all in this volume, and explanations for PC/FOCUS's built-in text editor, LINK, as well as for user assignment of function keys are mentioned only briefly. The *Guide to Operations* also lacks an index.

If the *Guide* is inadequate to introduce users to PC/FOCUS, the *User's Manual*, release 1.5, will surely drive them to despair. This encyclopedic volume (800-plus pages) is not even typeset and the quality of production is amateurish. The *User's Manual* has substantial problems with both its presentation and its content. Explanations are spread throughout the book in a way that mystifies the user. For example, information necessary to construct full-screen transactions with FIDEL is found under "Report Preparation and Transaction Processing." The book is repetitive and unclear in many places. The only bright spot is the 56-page index.

The *User's Manual* and the *Guide to Operations* are the extent of PC/FOCUS documentation. Information Builders does not provide a reference card, command summary, overview diagram, comprehensive self-starter's guide, or on-line tutorial. There is no effective effort to display and organize all PC/FOCUS language elements or explain in which of the several environments they have meaning. Studying the two PC/FOCUS manuals can establish a tone of obscurity and complexity that continues as the user works with the system.

PC/FOCUS does offer on-line help, although this is never a substitute for good documentation. A command such as HELP EX will give the user a screen or two of textual information about execute files. PC/FOCUS has about two dozen of these HELP keywords, and the information they reveal is satisfactory.

Information Builders provides telephone support, although it does not have a toll-free number and getting through can take awhile. Return calls are sometimes promised but not made promptly. The support representatives are helpful, generally courteous, and well aware that much of the product's problems are due to the poor quality of the system's documentation.

SYSTEM SECURITY

PC/FOCUS offers some amount of system security, although this is not as critical an issue on microcomputers as on mainframes. Users can be identified and restricted by means of a number of access restraints. Read, write, read/write, and update privileges can be assigned at levels as high as the file segment and as specific as a value test on a particular field. Restrictions can be applied to new and/or existing PC/FOCUS files.

```
USER=FRED,ACCESS=R,RESTRICT=
   SEGMENT,NAME=AUTHOR ,$
USER=CHAS,ACCESS=W,RESTRICT=
   VALUE,NAME=ISSUE, VALUE=VOLUME
   GT 3 AND VOL LT 5
```

Encryption is available for designated files in PC/FOCUS including .MAS file descriptor source and actual data files.

```
SEGNAME=AUTHOR,SEGTYPE=S2,
   ENCRYPT=ON...
```

Some of these encryption and user-protection facilities seem more than a single PC normally would require. However, in the kind of shared database environment that Multiuser PC/FOCUS will represent, these capabilities could have enormous value, especially in that they are integral to the system architecture, not merely post hoc add-ins.

An evaluation of PC/FOCUS from a strictly microcomputer vantage point leaves the reviewer wondering how the

product has achieved such widespread usage. Despite what seems like a steep price, PC/FOCUS has a distribution of 18,000. When compared to popular microcomputer-based DBMSs, PC/FOCUS is definitely more cumbersome.

The answer to this mystery lies in what large companies in the country are looking for when they shop for a data manager. Their needs—and, accordingly, their evaluation criteria—are vastly different from those of the small user. Nearly every organization to which PC/FOCUS would appeal already owns the mainframe version. Information Builders states that "almost all" PC/FOCUS systems it has installed to this point have been to existing users of the mainframe product, or to organizations buying both simultaneously.

Training costs for a system that operates identically on the PC as under VMS, CMS, or TSO amount to a fraction of what they would be if an alien data manager were chosen. Many companies have not just dozens of persons who might be using the system, but hundreds and sometimes thousands. From this perspective, the features that might annoy an experienced microcomputer user are familiar in a mainframe environment and become an asset in terms of compatibility.

File transfer is another significant consideration. Moving FOCUS data sets from the mainframe to a product on the PC that can directly use the file is clearly an advantage. Finally, the single vendor argument: a company already using FOCUS will have fewer software maintenance problems with PC/FOCUS.

Besides mainframe FOCUS users, applications developers are a major marketing target for Information Builders. To someone building and delivering to end users turnkey vertical applications, PC/FOCUS has some appealing qualities:

- Its heavy-duty file structuring capabilities allow complex applications models to be built. This is attractive because many real-life applications necessitate numbers of records and relationships; PC/FOCUS is definitely up to such a task. The other side of this structure issue—inherent lack of flexibility in changing files and database architecture—is less of a liability to the system integrator who is delivering a turnkey business solution to customers. These customers are not interested in making adjustments to file designs. Accordingly, in this type of market, flexibility requirements are secondary to file-structuring capacity.
- PC/FOCUS has a report/query language (TABLE facility) that is better than vir-

tually any other offering on the microcomputer market. Production applications systems invariably have heavy reporting requirements. Customers may want to meddle with a system's standard reports as well as add new ones. PC/FOCUS is a good vehicle for this.

- Information Builders is removing perhaps the single major stumbling block to applications developers' use of the system: lack of an adequate procedural language. PC/FOCUS Host Language Interface (HLI) will allow use of the system's facilities from FORTRAN, Pascal, and C, in addition to 8088 assembly language, and is supposed to be in general distribution this fall. HLI may obviate the need to access PC/FOCUS databases via the modify procedure's language.

Information Builders has announced a plan for runtime licenses of PC/FOCUS that will make the system attractively priced to major developers. This will allow execution-only copies of PC/FOCUS to be installed as part of an application at modest prices. In these cases, the customer will not be able to define other files in PC/FOCUS or otherwise use the system in ways beyond the turnkey application itself.

PC/FOCUS is not a product directed to the PC mass market. In the specific environments to which it is primarily directed—large companies that are existing users of mainframe FOCUS—the system has many strong points. These assets, however, do not revolve around PC/FOCUS's general capabilities and features as much as its compatibility and ease of training. Add to this compatibility a LAN version as well as the ability to speak intelligently with mainframe FOCUS (and in doing so ship files to and from the larger machines) and PC/FOCUS has more favorable qualities.

Simply as a PC-based data management product, however, PC/FOCUS must stand on its own merits when compared to competitive database management systems. While some aspects of it are attractive, its programming language is definitely a liability, offsetting to a great degree assets of powerful file structuring and a super report writer/query facility. A cumbersome and top-heavy user interface coupled with a steep price seems to make the single sale copy of PC/FOCUS a rara avis.

William Casey has been working with database systems on mainframes since 1972. He is president and founder of System Craft, Inc. in Washington, D.C., where he does independent consulting for database and on-line systems design and implementation.

Everything You Always Wanted To Know About

APPLICATION DEVELOPMENT DATABASES...

DATA

Just What Is DataFlex, Anyway?

The easiest thing to say is that DataFlex is an application development system *like* d-BASE. However, that wouldn't be a fair statement about either product because DataFlex is not only faster, more powerful and easier to use than d-BASE, but also supports TRUE multi-user transaction processing with complete data integrity. Applications developed with DataFlex can also be run UNCHANGED on a wide selection of 8 and 16-bit operating systems and LANs.

More Powerful and Easier To Use?

Absolutely. DataFlex uses "image formatting" to quickly and efficiently develop input screens and report formats for your application. All you have to do is make an "image" of your screen or form using any ASCII text editor. AUTODEF, DataFlex's file definition utility, automatically generates an error-free, ready to compile data entry program, creates the necessary data and key index files, and makes a data dictionary entry describing each field, its length, type and format. With DataFlex, there's no need for you to go back and provide tedious definitions of the length, format and data type of your windows. And while we're on the subject of text editors, you should know that DataFlex is also available with a full function word processing option that's operationally equivalent to and compatible with MicroPro's WordStar + Mailmerge.

What About A Procedural Language?

DataFlex has a powerful procedural language that combines the best features of Pascal, BASIC and RPG. It has over 125 commands in the following categories:

Argument Processing	Indicators
Console I/0	Key Procedures
Control	Multi-User Functions
Database Commands	Reporting
Definition	Sequential I/O
Data Entry	String Operations
Forms Processing	Structural Control
	System Commands

DataFlex allows programs of up to 2,750 command lines incorporating up to 255 screen images! This enables you to design systems far more complex and sophisticated than possible with some other database programs. For many applications, however, knowledge of the procedural language is not necessary since DataFlex's powerful AUTODEF and QUERY functions automatically generate the source code for handling data entry and reporting. Data checking and formatting commands and error traps can easily be added to the source code before compiling so your applications will run smoothly with minimal possibility of operator error.

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DataFlex utilizes a multi-keyed B+ ISAM structure which updates indexes on-line each time data is entered, deleted or edited. Since all data is instantly available for recall, time consuming key sorts and batch index reorganizations are not necessary. With DataFlex, you'll never again have to wonder whether or not your computer is really working or "hung-up" somewhere in the middle of a sort. DataFlex reports appear on your screen or printer as quickly as the data can be read from your disk. Data input is also speeded by DataFlex's FlexKeys™: single keystroke commands that perform record finding, saving and editing functions. There's even a HELP FlexKey that can summon instructions or explanations pertinent to your application.

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What's DataFlex Have For Those Of Us With Heavy Reporting Requirements?

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Concurrent CP/M-86
Concurrent DOS
MP/M-86
Novell NetWare
TurboDos
Corvus w/IBM PC
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TeleVideo Infoshare
3Com EtherShare
PC-Net
NorthStar Dimension
Action DPC/OS
DMS Hi-Net
Alloy Engineering RTNX

SPECIFICATIONS

Environment:
- 8080, Z80, 8088, 8086, 80186, 80286

Requirements:
- 52K TPA (8-bit)
- 256K TPA (16-bit)
- CRT w/cursor addressing
- 600K disk storage

Capabilities:
- 255 Database files
- No limit on number of open files (16-bit)
- 9 6-segment indexes per file (16-bit)
- 16K Bytes per record
- 255 Fields per record
- 16,777,215 Records/file
- 2,750 Program lines per configuration
- 255 Screens per configuration
- 2,900 Windows per configuration
- 32,000 Variables
- 127 Indicators
- 9 Global break point levels
- 18 Terminal independent function keys

Does DataFlex Work On MULTI-USER Systems and LANs?

Yes! DataFlex, unlike most other products, supports TRUE multi-user processing. With DataFlex, no user is ever locked out of a file or denied access to a record. Every user can, at any time, access, read and even change any record in the database while maintaining absolute data integrity!

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DataFlex includes an elegant menu system which totally insulates the end-user from the computer's operating system. Each menu screen supports up to nine prompted actions each, including chaining to "sub-menus" and DataFlex programs, and the execution of system commands and other programs. A pre-programmed "help-screen" is included to provide operator assistance on selecting items from the menu. Password security can be established for each menu action to prohibit unauthorized file access, and the passwords (or even the entire menu) can easily be changed at any time by programmers with access to DataFlex's MENUDEF utility.

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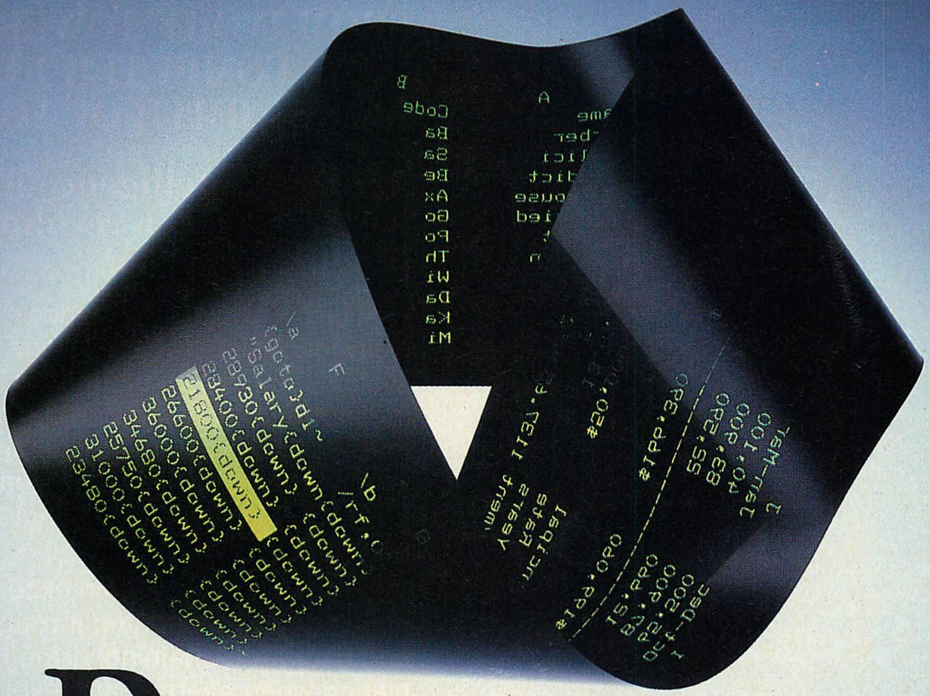

Programming in 1-2-3

The marriage of Lotus's versatile macros with some traditional programming command and data structures broadens 1-2-3 applications possibilities.

JORDAN LEE WAGNER

Lotus 1-2-3 macros are great time savers, but they also can build power into a worksheet with custom-designed menus and sets of help screens. The 1-2-3 macro menu command lets a programmer easily create a complex user interface by integrating Lotus's numerous worksheet and macro commands with structured programming discipline and data structures.

Used for convenience, macros simply store (act in place of) several keystrokes; they insert the company logo or print a report at the touch of a key. With minimal additional programming, the user can realize substantial extra mileage out of 1-2-3. The looping routines developed in this article permit wide-ranging, what-if analyses. A looping macro can juggle any number of input variables in search of an end condition of arbitrary complexity.

These techniques will be most useful to those who are familiar with all the native commands of 1-2-3, but who are relatively unacquainted with its macros and have done no 1-2-3 programming. However, even advanced 1-2-3 macro writers may encounter some new and worthwhile techniques, such

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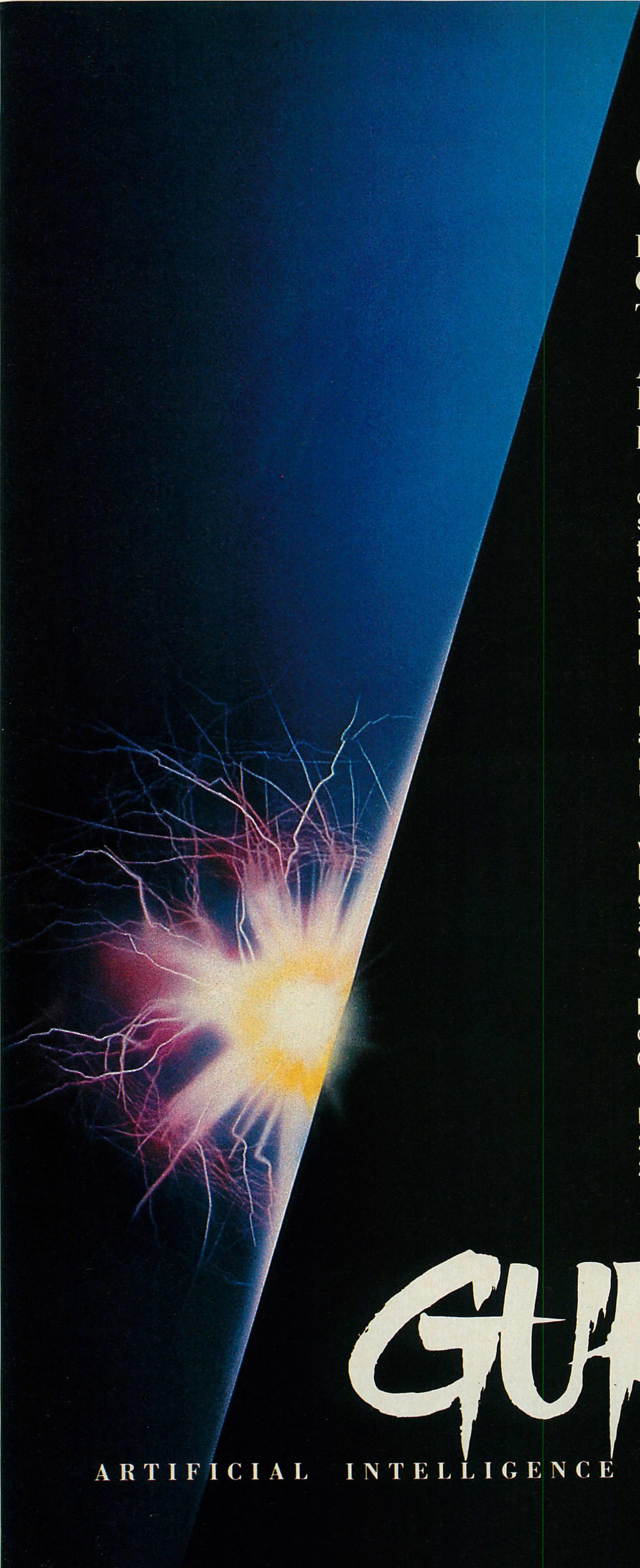

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as subroutine calls with parameter passing, nested while loops, and creating a macro that can determine where the user has left the cell pointer.

A 1-2-3 macro is a sequence of keystrokes stored in columns of worksheet cells. A cell may contain either a label or a value. Labels can begin with any character, but values begin only with a digit or any of the following symbols: +, −, $, @, #, (. Values are displayed according to the format of the cell. Labels are displayed according to a label alignment prefix that is stored with the label. 1-2-3 adds the prefix automatically, unless the label begins with a slash or any of the symbols used to begin values. In that case, the user must enter the prefix explicitly.

Normally, 1-2-3 responds to keystrokes typed by the user, but it can be told to receive its input from a cell in the worksheet. The label stored in the cell will be interpreted by 1-2-3 as a series of keystrokes being pressed by an incredibly fast typist. More generally, a macro is a cell or a single column of cells, each containing a label. The first cell in the macro must be a named range; 1-2-3 reads from the label in the named cell. It continues with the label in the next cell down. The macro ends when an empty cell is reached.

Macros that are invoked from the native command level of 1-2-3 are given a name that consists of a backslash followed by a single letter. A user invokes a macro by holding down the Alt key and simultaneously pressing the letter. It is a good practice to give subroutines within macros longer, more descriptive names and labels.

The Enter key, the cursor control keys, and other special keys are designated with symbols in 1-2-3's macro language. In general, a key's symbol is the name of the key surrounded by curly braces, for example, {right}, {home}, or {del}. The Enter key is an exception; its symbol is the tilde (~). The {calc}, {edit}, and {goto} keys permit very powerful operations within programs. Some keys, such as Scroll Lock and Ctrl-left, are not available in macros.

Macros provide new uses for some normal 1-2-3 commands. With the range input command, for example, forms-oriented database entry is possible in a macro. When 1-2-3 encounters /riRANGENAME~, it moves the window to the range named in the command. Typically, this range is an input form. 1-2-3 moves the cursor to the first unprotected cell in the range and allows the user to enter data in any unprotected cells within that range. The cursor keys will let the user move only among the unprotected cells.

Editing via the edit (F2) and the calc (F9) keys is permitted. A lone Enter keystroke on an input line ends the range input command, as does pressing Esc. The program then examines and uses the data in the input form.

SHOW SOME STYLE

Macro text is better (and more easily) designed in a clear, structured format. The examples included with this article are written in the three-column style of well-documented assembly language. The first column contains range names only in capital letters, the second column contains the macro code in lowercase letters, and the third column holds comments and explanations.

This format helps eliminate errors, especially those involving range names. Once the macro text is typed in, a single /Range Name Labels Right command sets the range names correctly; the user simply points to the first column.

It is important to remember that all macro commands are entered as labels. If a label begins with a formula or a 1-2-3 native command, it must be preceded by an apostrophe label prefix. Without the prefix, 1-2-3 will execute the command immediately. To actually include an apostrophe as the first character in a label, it must be typed twice.

A looping macro is capable of juggling any number of input variables in search of an end condition of arbitrary complexity.

Entering macro text and comments in lowercase helps to make code more readable. All range names embedded in the code should be in uppercase. During programming or debugging, visual scans are made more often for range names than for particular instructions; however, long range names should be shortened after debugging is completed because they will slow the macro down.

White space can be incorporated into code to allow long comments to extend over several lines, to separate related statements into groups, and to document each subroutine liberally. Because a macro stops when it reaches an empty cell, include a left label alignment prefix in each cell that should look empty. The macro will then continue, ignoring these cells.

Address all macro variables with range names. Actual cell references should never be used; macros do not include relative cell addressing. A move command may adjust addresses in formulas, but it will never change the addresses in a macro.

1-2-3 offers the most basic debugging facility: a single-step operation. In this mode, the user executes a macro, one keystroke at a time; pressing any key executes the next macro command. Single-step mode is started and ended by pressing Alt-F1. Fortunately, most macro bugs fall into three areas: a missing tilde after a macro command, empty white space cells (missing the apostrophe label prefix), and misplaced or forgotten range names.

It is a good idea to save worksheets before a program is tested. An omitted tilde is capable of destroying code. This error is usually evidenced by a rapid series of beeps as the rest of the macro quickly fills the command line: because the tilde is missing, 1-2-3 is typing the remaining portions of code, either as a label on the editing line, or as erroneous input to the command that needed the tilde.

Empty white space cells will halt the program. Macro code is displayed just as the macro will read it: as commands, not as labels. White space cells *look* just like empty cells on a worksheet. To find the error, move the cursor to each white space cell and check for the apostrophe label prefix. If a range name has not been defined, the macro will stop with a beep and display an appropriate error message. The range name used will be visible on the command line, making correction easy.

Figure 1 demonstrates the three-column macro style. Macro \j takes the label at the current cell pointer and concatenates it with the label in the cell beneath it. This is similar to the **join** command in FRED (the FReeware EDitor) or the IBM Personal Editor. Macro \j is self-modifying; STRING1 and STRING2 are both used as temporary data storage areas. Initially empty cells, they are filled by the time 1-2-3 is ready to read keystrokes from them. This macro can be invoked by the user repeatedly without first erasing the old contents of STRING1 and STRING2.

1-2-3 provides four pause and prompt commands. The simplest, {?}, causes 1-2-3 to pause and return control to the user. This symbol often is used to allow the program to accept user in-

FIGURE 1: *String Concatenation*

```
\j      /c~STRING1~       copy label at cell pointer to STRING1
        /c                start the copy command
        {esc}             un-anchor the cell pointer
        {down}~           point to cell beneath current cell...
        STRING2~          ...and copy its label to STRING2
string1                   now the first string is typed...
string2                   ...and then the 2nd string is typed
        ~                 put the result in the current cell...
        /re{esc}{down}~ ... and erase the cell beneath it
```

This self-modifying macro performs string concatenation; two adjacent strings in a column are combined. The three-column design of assembly language works well in 1-2-3 macros.

FIGURE 2: *Check Register*

```
\c   {?}          user types the check number
     {right}      enter # and move to "date" field
     @date(85,    begin to enter the date
     {?})         the user types: month,day,enter
     {right}      enter date and move to "payee" field
     '{?}         typed input will be a label
     {right}      enter payee and move to "amount"
     {?}          type the amount
     {down}       enter amount and move to next check
     {end}{left} go to next check's number
```

The versatile {?} prompt helps the user create a four-column check register. Note the three-column format: labels on the left, macro code in the center, and comments on the right.

put, either selections from large menus on the screen or information which it needs to continue. The macro continues when the Enter key is pressed.

The user is in full control once 1-2-3 has paused for input; he can delete rows, erase files, move the cell pointer, and so on. A series of operations can be performed before control is returned to the macro using cursor keys to enter data and invoke commands by their initial character rather than by pointing. The user *cannot* invoke a second macro while the program is pausing. Further, 1-2-3 does not interpret the pressing of the Enter key to end the input routine as part of the input. Therefore, a tilde character or a cursor movement key must be inserted in the macro right after the bracketed question mark.

Figure 2 shows how to use {?}. Macro \c helps the user create a check register. The columns contain the check number, date, payee/memo, and check amount. This macro assumes that the cell pointer is in the left column on the row after the last recorded check or deposit. To record a new check, the user presses Alt-c. Notice the use of {?} within the function to simplify date entry, and the apostrophe before {?} when entering the payee field. The apostrophe creates a label prefix so that an error will not result from an entry such as 1st National Bank.

The {?} command is quite versatile, but sometimes a more traditional prompt and input is needed. The execute commands, or x-commands, provide other options. The x-commands are designed for programmers; they can be used only in macros. 1-2-3 has two for prompting: one for labels, the other for numeric input. The formats are:

/xlPrompt~CELLNAME~	"get-label"
/xnPrompt~CELLNAME~	"get-number"

The /xl and /xn commands display a prompt at the top of the screen and accept input from the user. The user's

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response is stored in the cell specified in this statement.

These input commands do not move the cell pointer or window. They use much less worksheet space (memory) than range input with a data entry form. Either command can be used to pause while the user reads a screen. Use **/xl~ DUMMYCELL~** to store user's response in a cell that the program ignores. The /xl command limits the user's activities more than {?} does.

The fourth type of input pause is an ingenious use of the /xm menu command. It permits two-line prompting with minimal user control; this special application is described further below.

PROGRAMMING COMMANDS

Built-in 1-2-3 commands permit simple program control. Versions of goto, if, call, return, and end are available:

/xgCELLNAME~ "x goto". This command transfers program control unconditionally. The name of a cell follows **/xg**; when 1-2-3 encounters this statement, it begins reading keystrokes from the macro at the named cell. This command should not be confused with the {goto} function normally provided by the F5 key, and also available within macros.

/xiCondition~keystrokes "x if". The execute-if command transfers control conditionally. When 1-2-3 encounters an /xi line, it tests the condition. If the condition is true, the remaining keystrokes in the cell will be interpreted. Otherwise the remaining keystrokes are skipped and execution continues at the next cell down. If the condition consists of a formula, it is considered true when the formula has a nonzero value and false when the formula evaluates to zero.

/xq "x quit". This is the end statement in 1-2-3's macro command language. When 1-2-3 comes to /xq, the macro halts and control is returned to the user.

The above commands are all that are necessary for writing simple macros. Figure 3 shows a typical spreadsheet problem and its macro solution. When a database is sorted in 1-2-3, a report similar to that in figure 3 may be requested. Every row of the report contains an entry in the columns containing the sortkeys. The readability of the report is improved when each value of a key appears only once in the column.

Macro \s performs nested looping and testing to fine-tune the report. To use the macro, position the cell pointer at the top of the column of the report and press Alt-s. The four cells that precede the macro are variables. NROWS holds the number of rows in the column; this is determined by the first four lines of the macro. Macro \s will not work if range name HERE already exists; it is deleted in the fifth line to make the macro reusable.

Once NROWS is known, the macro enters a loop. Each iteration of the loop operates on one row. COUNTER holds the number of rows that already have been processed, NEWVALUE contains the value in the current row, and TESTVALUE holds the value that was in the previous row. The loop continues until COUNTER=NROWS.

The data fill command has found special use here. In its use outside of macros, /df puts a sequence of numbers into a range of cells. It uses a starting value, an increment amount, and a final value that the user may specify; the 1-2-3 default values are, respectively, 0, 1, and 2,047. However, /df can operate on a single cell, rather than a range. In this case, only the starting value is used.

This form of **/df** is very useful in macros. Data fill can enter or copy information anywhere on the worksheet, without moving the cell pointer or the display window. Often the user needs to do work without moving the cell pointer. This command copies the current values of formulas without including {calc} in the macro. It can lead to a faster execution because it requires the 1-2-3 macro interpreter to read fewer keystrokes. For example, macro \s uses /df to increment COUNTER; without /df the code might be:

```
/rncHERE~{goto}COUNTER~{edit}+1{calc}~
   {goto}HERE~/rndHERE~
```

Macro \s can be put to other uses. For example, it can be used to measure the number of columns and to set up two counters to loop through the array. Figure 3 illustrates a general purpose looping technique that is appropriate for many different applications.

Finally, 1-2-3 allows for 16 levels of subroutines. Its two most familiar call and return commands are:

```
/xcSUBROUTINE~      "xecute a call"
/xr~                "xecute a return"
```

When 1-2-3 encounters /xc, it transfers control to the macro at the cell named in that statement. Later, when 1-2-3 encounters /xr, it returns control to the original macro. Execution will then continue with the keystrokes immediately following the /xc statement.

STACKS AND LOOPS

The following macros enhance 1-2-3's programming language; they include a stack, local parameter passing, bounded do loops, and unbounded while loops.

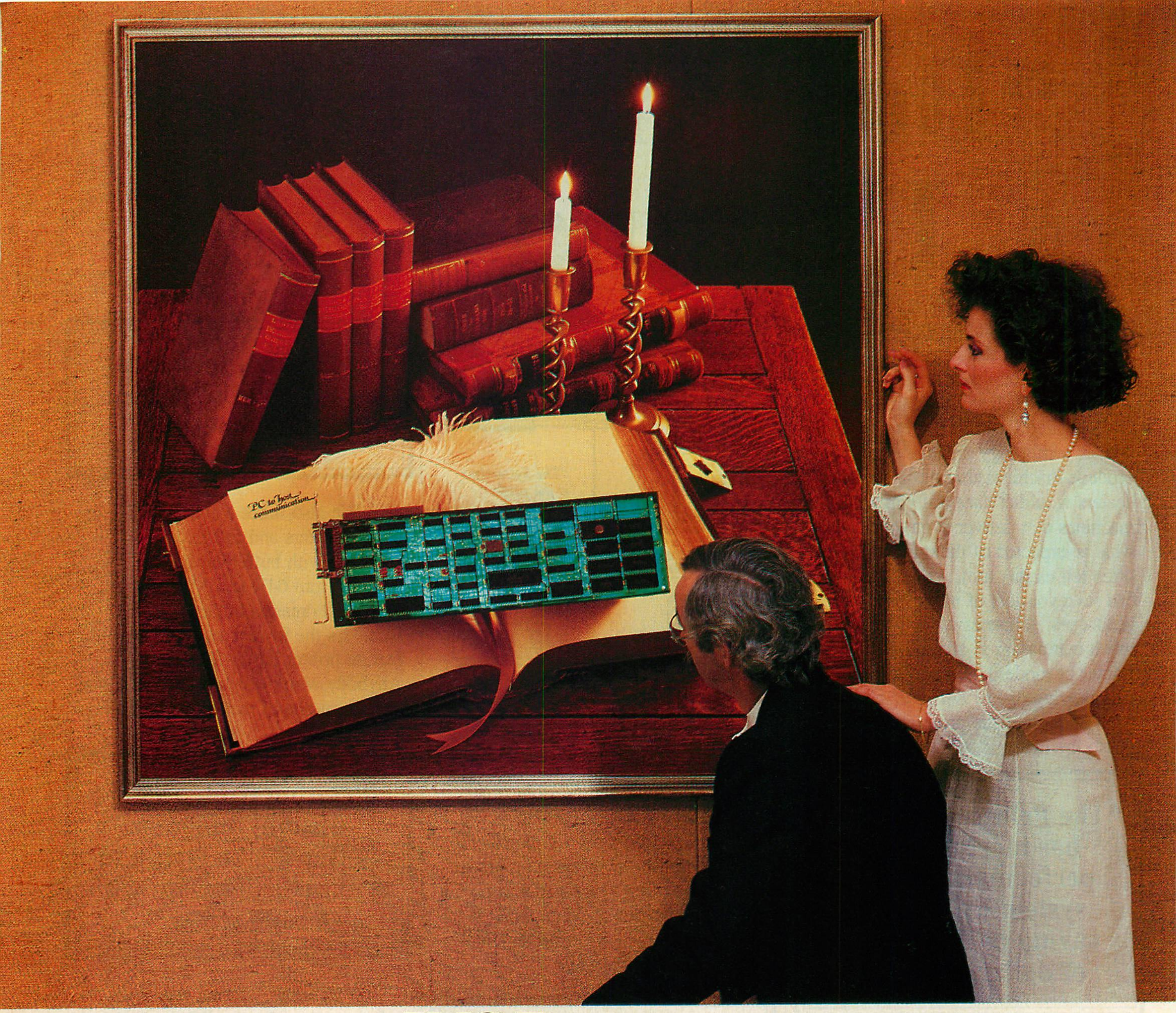

FIGURE 3: *Sample Data Table*

Costs of Hospitalization				Costs of Hospitalization			
Dept.	Acct.	Patient	Cost	Dept.	Acct.	Patient	Cost
1	1	xxx	xxx	1	1	xxx	xxx
1	1	xxx	xxx			xxx	xxx
1	2	xxx	xxx		2	xxx	xxx
1	2	xxx	xxx			xxx	xxx
1	3	xxx	xxx		3	xxx	xxx
2	1	xxx	xxx	2	1	xxx	xxx
2	2	xxx	xxx		2	xxx	xxx
2	2	xxx	xxx			xxx	xxx
2	2	xxx	xxx			xxx	xxx
2	3	xxx	xxx		3	xxx	xxx
2	3	xxx	xxx			xxx	xxx

```
NROWS                           number of rows in the column
COUNTER                         loop control variable
TESTVALUE                       stores previous number
NEWVALUE                        next number in column; tested against
                                TESTVALUE.

\s    /rncHERE~                 create a range named HERE
      {end}{down}~              make HERE the whole column of numbers
      /dfNROWS~                 put into NROWS...
      @count(HERE)~~~              ...the # of cells in the column
      /rndHERE~                 so the cell pointer won't move during
                                /rnc.
      /dfCOUNTER~0~~~           Start counting rows with zero
loop1 /c~TESTVALUE~             copy cell pointer contents to
                                TESTVALUE.
loop2 {down}                    move to next row
      /xiCOUNTER=NROWS~/xq      exit the macro if there are no more
                                rows
      /dfCOUNTER~               increment the row counter
      COUNTER+1~~~
      /c~NEWVALUE~              copy cell pointer contents to
                                NEWVALUE.
      /xiNEWVALUE=TESTVALUE~/re~/xgLOOP2~
      /xgLOOP1~                 erase current location if a duplicate.
                                otherwise, update the TESTVALUE
                                without erasing.  In either case,
                                loop to the next row.
```

A nested loop creates a more readable data table. Repetitions in the Dept. and Acct. columns are removed from the example at top, left, to produce the table at top, right. Two /x commands are used in the \s macro: /xi (if) and /xg (goto).

FIGURE 4: *A 1-2-3 Stack*

```
push      /xiCNT>=MAX~/xgOVERFLOW~  Is stack full?
          /rncTOS~{down}~           No: move stack pointer
          /c~TOS~                   push data
          /xr                           all done
overflow  STACK OVERFLOW            Yes:error message

pop       /xiCNT<=0~/xgUNDERFLOW~   Is stack empty?
          /cTOS~~                   No: pop data
          /reTOS~                       clean the stack
          /rncTOS~{up}~                 move stack pointer
          /xr                           all done
underflow STACK UNDERFLOW           Yes:error message
```

These push and pop macros perform stack operations on labels and numbers. The operations are accomplished with the help of four labels: STACK, a range of cells; CNT and MAX, index storage cells; and TOS, a moving stack pointer.

FIGURE 5: *Pushdata and Popdata*

```
stackdata                               a data transfer area

pushdata   /xiCNT>=MAX~/xgPUSHDOVER~
           /rncTOS~{down}~
           /cSTACKDATA~TOS~             copy from STACKDATA, not the
                                        cell pointer
           /xr
pushdover  STACK OVERFLOW

popdata    /xiCNT<=0~/xgPOPDUNDER~
           /cTOS~STACKDATA~             copy to STACKDATA, not the
                                        cell pointer
           /reTOS~
           /rncTOS~{up}~
           /xr
popdunder  STACK UNDERFLOW
```

The push and pop of figure 4 access the cell of each label to be pushed or popped. Because push and pop move the cell pointer, this is not always the best method; the pointer's old location is lost. These macros access one cell: STACKDATA.

The stack discussed here is a column of cells with the range name STACK. It references an entire range of cells, *not* a single cell like other range names in this article. (Do not use Range Name Labels Right to set up STACK; the stack region must be described explicitly.) STACK is not a single cell, it is a vertical range of cells. The cells labeled MAX and CNT contain the length of STACK and the formula @count(STACK), respectively. CNT keeps track of stack size; if there are 3 labels in the stack, CNT=3. The cell on the top of the stack is labeled TOS. TOS begins one cell above STACK and moves down the worksheet as the stack grows.

The next step is to implement **push** and **pop** on the 1-2-3 stack (see figure 4). **Push** tests to see if the stack is full; if it is not, **push** moves TOS so that the most recent datum stored will not be overwritten. It then copies the contents at the current cell pointer to the new top of the stack. The stack actually grows downward in the worksheet. If the stack is full, **push** leaves an error message in the control panel. This error message halts execution.

Pop performs an operation that is the opposite of **push**: it tests to see if the stack is empty. If it is not empty, **pop** copies the data at the top of the stack to the current cell pointer. Then it erases that data from the stack. Finally, it moves TOS to the previously stored data. If the stack is empty, **pop** leaves an error message in the control panel and, again, execution halts.

The **push** and **pop** of figure 4 work with numbers and labels only; empty cells and formulas with relative cell references cannot be copied safely onto the stack. But this is fixed easily by editing each cell and inserting a label prefix and a space in **push** that are removed later in **pop**. The examples in this figure have one major shortcoming: they do their work within the current cell. It is often necessary to isolate stack operations. This is accomplished with the macro subroutines **pushdata** and **popdata** which operate on the buffer cell STACKDATA (see figure 5). No formula pushes or pops are required by the macros that follow.

Subroutines can be written that pass parameters via the stack. This capability enables the user to build reentrant programs, use while loops that can be nested, and add other familiar programming constructs that broaden the productivity of Lotus 1-2-3.

It is often useful to know where the user has left the cell pointer. The macro subroutines in figure 6, **pushpointer** and **poppointer**, determine this and let the user restore the cell pointer to that position after disturbing it.

FIGURE 6: *Pushpointer and Poppointer*

```
pushpointer
     {edit}{home}'~       ensure that the cell contains a label
     /c~SAVED~            save current cell contents
     +                    type a formula...
     {right}                 ...in pointer mode
     {left}               point to the original cell
     ~                    enter formula in worksheet
     {edit}               go to edit mode
     {home}               put cursor at start of formula
     '{del}~              turn formula to label, remove '+'
     /xcPUSH~             push the label, which is the address

saved                     retype the original contents of cell
     ~                    enter it into the worksheet
     /xr                  exit the routine

poppointer
     /xcPOPDATA~          retrieve the address to go to
     /cSTACKDATA~RESTORE~ put in this self-modifying macro
     {goto}               go to...
restore                      ...the popped address
     ~/xr                 exit the routine
```

A macro that uses pushpointer and poppointer is able to execute its operations without altering the label or formula in the current cell.

FIGURE 7: *Do Loop*

```
The initialization routine:
\t   /dfSTACKDATA~N~~~/xcPUSHDATA~        push N, the # of iterations
     /xcPUSHPOINTER~                      save cell pointer
                                          position...
     /xcPOPDATA~                             ...in STACKDATA
     /xcPUSHDATA~{goto}TOS~TYPE_A_MSG~    push the loop's name
     /xcPUSHDATA~/xcPOPPOINTER~           restore the cell pointer
     /xcDO_LOOP~                          do the loop N times...
     {down}                               ...and then continue here
     The loop is over.~
     /xq

The body of the loop:
type_a_msg                                start of the loop
       Executing the loop
       {down}
       /xr                                end of the loop

The DO_LOOP utility routine:
do_loop /xcPOPDATA~              take loop's address off stack
     /xiTOS<1~/xcPOPDATA~/xr     Test the counter.  If 0: then
                                    clean the stack and exit.
                                 If not 0:
     /dfTOS~TOS-1~~~             decrement counter
     /xcPUSHDATA~                put loop's address back on stack
     /cSTACKDATA~DO_RET~         copy loop's address into /xc
                                 command
     /xc                         transfer program control...
do_ret                              ...to the beginning of the
                                 loop...
     ~                                ...now.
     /xgDO_LOOP~                 On return, test for another
                                 iteration.
```

A stack permits easy bounded looping. Macro \t takes a subroutine name and iteration number, here TYPE_A_MSG and N, respectively. With parameters as shown, macro \t will type "Executing the loop" 10 times beginning at the current cell; the macro will end by typing "The loop is over."

FIGURE 8: *While Loop*

```
While loop initialization:

\W   /xcPUSHPOINTER~                      save cell pointer
                                          position...
     /xcPOPDATA~                             ...in STACKDATA
     {goto}CONDITION~/xcPUSHPOINTER~      push the address of the
                                             condition to be tested
     /xcPUSHDATA~{goto}TOS~TYPE_A_MSG~    push the loop's name
     /xcPUSHDATA~/xcPOPPOINTER~           restore the cell pointer
     /xcDO_WHILE~                         do the loop until the
                                             condition is satisfied...
     {down}                               ...and then continue here
     The loop is over.~
     /xq

The DO_WHILE utility routine:

do_while
      /xcPOPDATA~               take loop's address off stack
      /cTOS~WHILE_TEST~         put the address (label) of
                                   the condition in W_TEST
      /dfWHILE_TEST~            Convert the address-label...

while_test                         ...to the value of the
      ~~~                       condition at that address.
      /xiWHILE_TEST=FALSE~/xcPOPDATA~/xr
                                Test the counter.  If 0: then
                                   clean the stack and exit.
                                If not 0:
      /xcPUSHDATA~              put loop's address back on stack
      /cSTACKDATA~WHILE_RET~    copy loop's address into /xc
                                command
      /xc                       transfer program control...

while_ret                          ...to the beginning of the
                                loop...
      ~                               ...now.
      /xgDO_WHILE~              On return, test for another
                                iteration.

end_do   /xcPOPDATA~/xcPOPDATA~/xr   clean the stack & exit loop
```

A while loop is implemented with the 1-2-3 stack. A subroutine name is passed to do_while at the top of the stack with the address of a test condition below. The while loop executes the subroutine until the condition is false.

FIGURE 9: *Mailing List Manager*

```
\0        /xgMAIN~
\A        /xg\0
main      {goto}MAINHELP~{goto}MAINBOTTOM~/xmMAINMENU~/xgMAIN~
mainmenu  WRITE           UTILITIES          QUIT
          View or Edit    Sort or Print list Abandon current list
          /xcWRITE~       /xgUTIL~           /xgQUIT~
          /xgMAIN~

quit      {goto}QUITHELP~{goto}QUITBOTTOM~/xmQUITMENU~/xgMAIN~
quitmenu  CONTINUE        NEW LIST           EXIT
          Continue work   Get different list End session
          /xgMAIN~        /xcNEW~            /xgEXIT~
                          /xg\0~

util      {goto}UTILHELP~{goto}UTILBOTTOM~/xmUTILMENU~/xgMAIN~
utilmenu  SORT            REPORT             1/3-ACROSS
          Sort list       Print mailing list Print labels column
          /xcSORT~        /xcREPORT~         /xgUTIL~
          /xg\0~          /xg\0~

exit      {goto}EXITHELP~{goto}EXITBOTTOM~/xmEXITMENU~/xgQUIT~
exitmenu  NO          YES
          Cancel      Exit the Mailing List Manager.
          /xgMAIN~    /qy
```

The above workspace is the unfinished framework of a mailing list manager. It provides an example of top-down design using the powerful menu command (/xm), a command that permits customized menus that act just like 1-2-3's own. With /xm, the programmer may specify as many as eight menu options; he also supplies the description that appears when the cursor highlights a menu option.

Pushpointer creates a formula in point mode and converts it to a label. If Hl is the current cell and it contains the label 'balance, pushpointer saves 'balance and uses pointer mode to enter the formula +Hl in Hl. Then it pushes the label 'Hl and restores 'balance to cell Hl. **Poppointer** gets 'Hl off the stack and executes a {goto} Hl. Stack use in this case is a convenience and not necessary to **pushpointer's** maneuver.

1-2-3 looping can be implemented cleanly with a stack. The bounded loop of figure 7 has four components: the stack with its **push** and **pop** routines, a subroutine to be iterated, an example of a main **\t**, and a re-entrant loop control routine. After **\t** has prepared the stack, it contains the name of the subroutine and the number of iterations to be performed. These two pieces of information completely specify a loop. DO_LOOP takes these parameters and calls the TYPE_A_MSG subroutine as it decrements the iteration number.

Pushpointer and **poppointer** are indispensable to macro **\t**. The data fill command prepares N to be pushed onto the stack without affecting the current cell. It is not easy to push the loop's name onto the stack. When 1-2-3 reaches the TYPE_A_MSG~ sequence, it will put the name in the current cell. This process would overwrite the contents of the original cell, except for **pushpointer** and **poppointer**.

The address of the original cell is saved with **pushpointer**. Now the current cell can be changed safely to TOS. The loop's name is written to TOS and only one problem remains: the original cell's location is sandwiched between N and TYPE_A_MSG~ on the stack. The stack's uppermost two elements are swapped, thus leaving the cell's location on top. **Poppointer** restores the cell pointer to the original cell.

To use DO_LOOP, pass it a subroutine name on the top of the stack with an iteration number below it. Nesting is limited only by the size of the stack, and N can be a number, a formula, or a cellname referring to a number or formula. The **/df** command will evaluate N before it is pushed.

When executed, the loop example in figure 7 will write, "Executing the loop" at the current cell pointer, and then move down one cell. It will do this N times. Upon exiting the loop, the program will skip a line and finish by typing, "The loop is over."

A while loop executes until its condition is false. Figure 8 produces the same output as figure 7, but uses a while loop. When Alt-w is typed, the current cell address is saved with **pushpointer** and popped into the buffer address STACKDATA. **Pushpointer** is used again to push the condition address. The subroutine name is written directly to TOS so STACKDATA is not overwritten. **Pushdata** transfers the current cell address from STACKDATA to TOS. **Poppointer** returns the cursor to the original address. The stage is set for the first iteration of subroutine **type_a_msg** to produce its output at the original cell.

Do_while makes quick work of condition testing with help from the data fill command and self-modifying code. The condition's address is copied into the program at **while_test** and **/df** evaluates the function at the address. The **do_while** routine is similar to the **do_loop** routine. To use it, pass **do_while** the subroutine address on the top of the stack with the condition address beneath it.

A 1-2-3 while loop can perform what-if analyses. By nesting while loops, a program can vary many input cells in a complex worksheet, trying all combinations. The loops end when a combination of input values is found that produces output cells satisfying some special condition. (Compare this to the data table 2 command, which accepts two inputs and does not call attention to a particular result.)

A COMPLETE APPLICATION

The menu command enables the 1-2-3 programmer to combine a collection of macros into an application that is coherent and user-friendly. Custom menus appear in the command window just as with the ordinary 1-2-3 menus. The user can select items from the keyboard or use pointer mode. The format is:

/xmMENUNAME~ **"xecute a menu"**

To create a menu, list a maximum of eight items in a single row in adjacent columns. An empty cell defines the end of the list. The range name given in the **/xm** command is the name of the cell that contains the first menu item.

In the cell beneath each menu item, put a description of that item. These descriptions will appear on the third line of the command window when the user points to them. The cells beneath each of the description cells must contain the macro to be read if that item is selected from the menu. When the user makes a selection, 1-2-3 will unconditionally branch to the cell in the macro beneath that item's description. Prompts or menu items can be left blank by placing spaces or a label alignment prefix in the cells.

An application disk can be designed to boot directly to an opening main menu. When 1-2-3 starts, it checks its default directory (not DOS's) for a file called AUTO123.WKS. If this worksheet exists, 1-2-3 loads it automatically. The program also provides for auto-executing macros. If a macro named **\0** exists, 1-2-3 will execute it as soon as a worksheet is loaded. A user may not even be aware of 1-2-3; he may simply be instructed to insert the Lotus disk in drive A:, the application disk in drive B:, and turn on the PC.

Complex programs with many branches can be built around the menu command. The program macro in figure 9 is a mailing list manager in the first stages of development. When 1-2-3 loads this worksheet, it will execute the macro at \0. This routine transfers control to the main part of the program.

The display window is moved to an opening help screen, then the cell pointer is moved to an attractive place on that screen. This could be the upper right or bottom left corner, so that the pointer looks like an extension of the inverse video border. Then 1-2-3 is told to execute the main menu.

The main menu contains three items: WRITE, UTILITIES, and QUIT. 1-2-3 will display this menu on the second line. The first item will be in inverse video. On the third line, the following prompt appears: "View or edit." Just as in a 1-2-3 menu, the user changes the highlighted item using the cursor keys; 1-2-3 shows the appropriate prompt for each item. A highlighted item then is selected from the menu by pressing the Enter key.

Each item in the menu starts with a different letter. This permits an experienced user to execute commands more rapidly by typing the first letter of a choice, without pointing. In the case of duplicate initials, 1-2-3 selects the first item it encounters with the initial.

Most of the main menu choices in figure 9 are branches to other menus. For example, selecting UTILITIES triggers another help screen and presents a menu that allows the user to sort the mailing list, print the database in a compact report rather than on labels, change the printing of labels from 1 across a page to 3 across, and adjust the position of the address on the label. Eventually, the user will select a menu item that actually executes a subroutine. Suppose, for example, the WRITE command is selected. 1-2-3 will execute WRITE and return to the main menu.

When a user presses the Esc key while in a menu, 1-2-3 returns to the **/xm** statement and continues the macro from there. For example, look at **util** in figure 9; it contains several keystrokes in the cell after the **/xm** command. This feature permits users to back up through menus when they have taken a wrong turn. The example in figure 9 uses help pages and page bottoms to maintain control of what the user sees. Programmers should keep the screen in mind when coding and beware of statements that must move the cell pointer as they work. This can be confusing to the user, and, in some cases, it can slow the program's execution.

Experienced 1-2-3 programmers often use the **/xm** command for completely controlled input. A special form of **/xm** permits a prompt that leaves the user only two choices. The user sees a two-line prompt in the command window with the first line in inverse mode. 1-2-3 will wait for the user to press Enter or Esc or the space bar. Pressing any other key will cause 1-2-3 to beep and wait for a correct entry.

This prompt can be produced by creating a menu with a single item. The item label should begin with ' '. The user can then execute the subroutine below the item description by pressing Enter or the space bar. His only other option is to execute the command that follows the **/xm** by pressing Esc.

A split screen will help to minimize jumping in situations where a macro's execution causes the display window to move back and forth between two widely separated locations. The added window should be as small as possible (one column wide). Its vertical border should be at the far right side of the display. The windows should be unsynchronized and the larger original window can be positioned at a help screen or other pertinent cell range. The program can then switch to the small window to do its work.

Lotus 1-2-3 continues to evolve as the premier spreadsheet program. The examples of program expansion and refinement discussed here only suggest the applications possible using 1-2-3 with the addition of some traditional programming practices.

Jordan Lee Wagner is an applications developer in assembly language and Lotus 1-2-3. He lives in the Boston area and is an active member of the Boston Computer Society.

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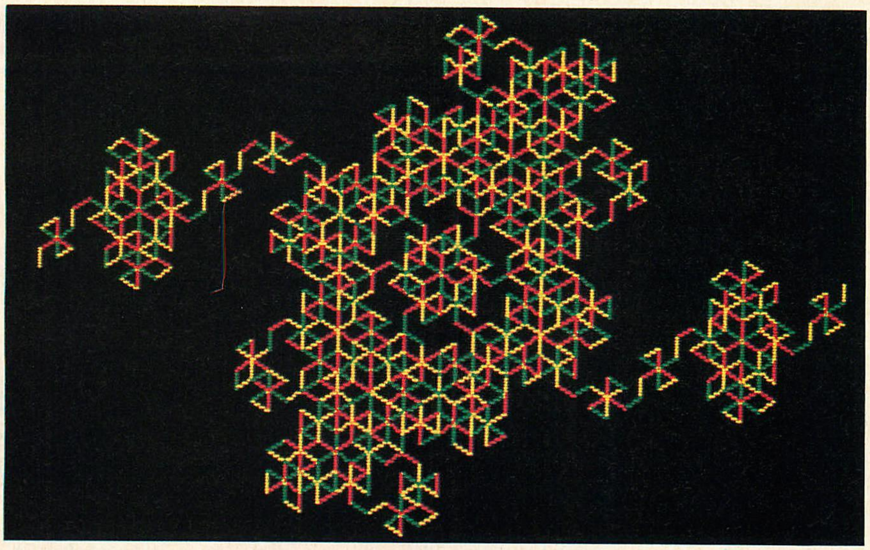
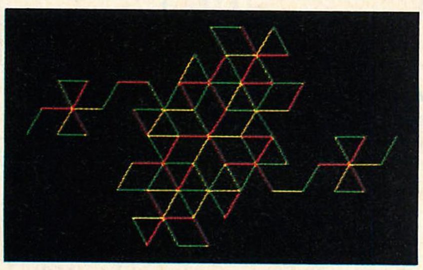


Fractals for the PC

These programs illustrate three methods for creating fractal curves using BASICA.

EUI IN LEE



Articles about fractals and "experimental" mathematics have appeared in several magazines recently (see the articles mentioned in the references section at the end of this article). Fractals are becoming popular not only in pure mathematics but also in abstract arts and in movie-making. A fractal pattern is beautiful and fascinating and it has a recursive property; the patterns tend to replicate themselves on smaller and smaller scales. A flower blossoms into petals, each of which blossoms into smaller petals, and so on.

The beautiful figures and drawings in the articles mentioned above were generated using large mainframe computers with high-resolution color terminals. This traditionally has been the case because producing fractals requires a great deal of computing time and because low-resolution graphics terminals simply do not provide enough information. However, when the IBM PC opened the door to a whole generation of small personal computers, it soon became possible to use them for plotting fractals (provided they have reasonably good graphics capabilities).

A fractal curve is simple, yet infinitely complex—simple because it is made with a simple shape; infinitely complex because this simple shape is repeated many times, at smaller and smaller scales. Three examples of fractal curves were shown in the April 1985 issue of *PC Tech Journal* ("Recursive Curves," Eui In Lee, p. 171): the Hilbert and Sierpinski curves shown in that article are, in fact, fractal curves.

A rigorous definition of a fractal curve would require a long digression into mathematical details. It is not that difficult, however, to write a computer

program to generate and plot fractal curves, if the computer used is equipped with a reasonably good high-resolution graphics capability. Writing such a program is worth the effort not only because it is an interesting exercise in recursive programming but also because the results are often unexpectedly beautiful.

The term *fractal* was first coined by the French mathematician Benoit Mandelbrot as he attempted to explain some forms and chances that exist in nature. The term represents something that is irregular, broken, or fragmented, with recursive properties. In this article, only nonrandom, mathematical fractals are considered. If a random factor is added to the program, "natural" fractals (fractals similar to those found in nature: mountain ranges, the shape of a river, cloud patterns, and coastlines) can be generated.

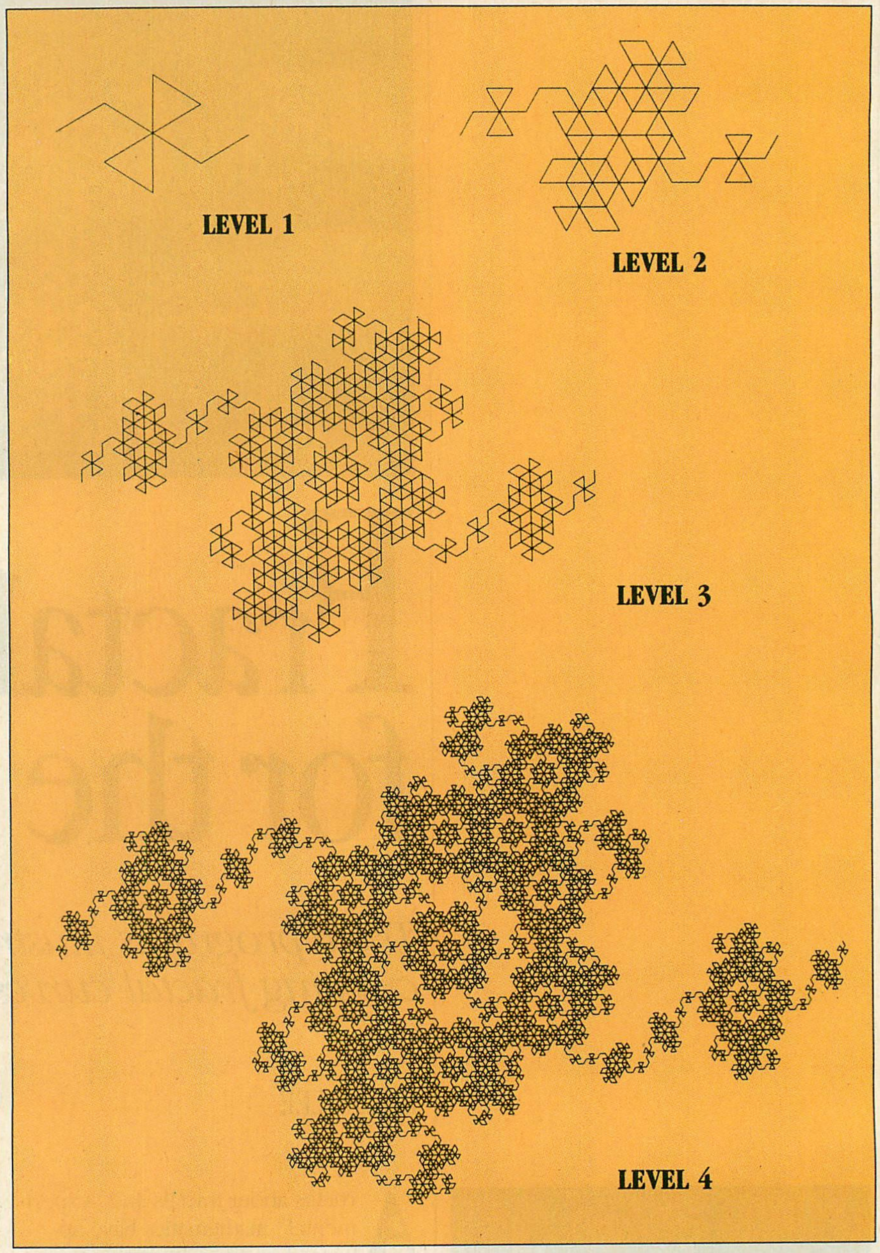
The process of creating a fractal curve begins with a line segment (called an *initiator*). This line segment is then replaced by a simple shape (called the *generator*), and each line segment in this generating shape is replaced by the same shape but in a smaller scale (called the *recursion*), and so on. In theory, this replacement can continue infinitely, but in practice it can continue only as long as each line segment can be identified and until processing time becomes impractically long. Three to five stages (or levels) are usually good enough, depending on the complexity of the curve.

Defining and measuring fractal curves is difficult. A fractal curve, by definition, has an infinite length, but it may surround a finite area. Mathematicians are not comfortable considering a fractal curve as a one-dimensional entity, but it plainly is not two-dimensional in nature. To solve this problem, the term *fractal dimension* was created to describe the particular niche between one- and two-dimensional entities that is occupied by fractal curves.

Fractal curves, therefore, are considered to have a dimensional value between 1 and 2. Roughly, this dimension is a measure of the extent to which the fractal curve "fills" a two-dimensional area. A fractal curve with a dimensional value of 2 completely fills the area. (Hilbert and Sierpinski curves are two famous examples of such curves.) Sometimes two different fractal curves can have the same fractal dimension.

Three different BASIC programs for drawing fractal curves are presented here. The first method utilizes angles and the relative-drawing technique; the second method uses arrays and the absolute-drawing technique. The last method manipulates string arrays and the DRAW statement with a graphics definition language, available on the IBM PC and PC*jr*.

FIGURE 1: *Pinwheel*



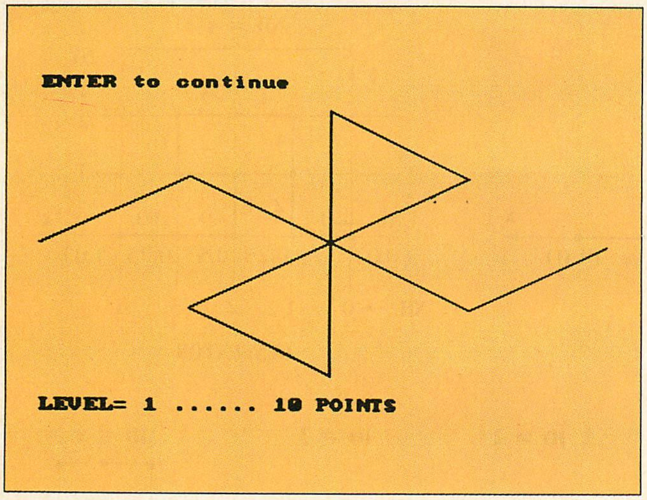
Above are four levels of the pinwheel curve, which can be produced by DAM.ASC or AEM.ASC. This example is printed by a high-resolution plotter.

DIRECT ANGLE METHOD

This method does not require much memory, but its capability is somewhat limited. Each line segment in the generator should be of the same length, and curved line segments cannot be used in the generator. This method is recommended for home computers with less than 64KB of RAM. The DAM shown in listing 1 can draw four different fractal curves with the data points provided: the sausage-link curve (data at line 520); the pinwheel curve (data at line 550); the arrowhead curve (data at line 580); and the hexagonal-connection curve (data at line 610). To switch from one of these curves to another, alter the RESTORE <LN> statement in line 70.

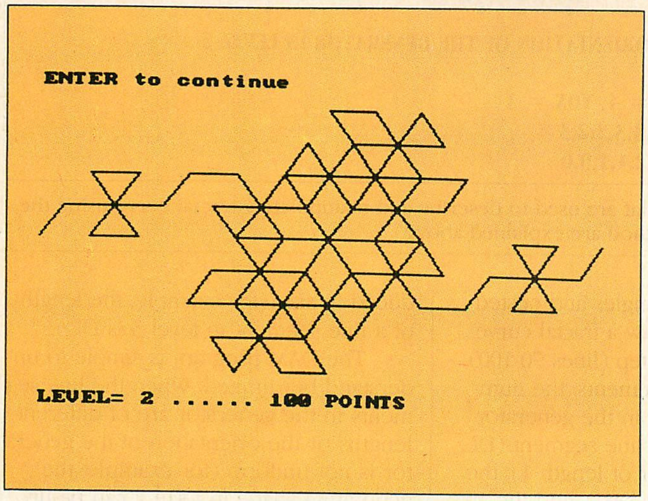
Photos 1,2, and 3 show levels 1, 2, and 3, respectively, of the pinwheel curve as they appear on the PC*jr*'s screen. Figure 1 shows the same pinwheel curves as drawn by a high-resolution plotter. (Level 4 of the pinwheel curve is also included in figure 1.)

PHOTO 1: *Pinwheel, Level 1*



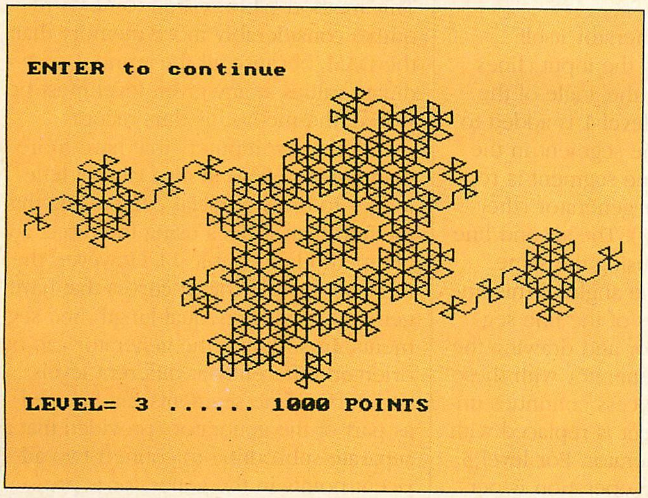
Level 1 of the curve produced by DAM.ASC.

PHOTO 2: *Pinwheel, Level 2*



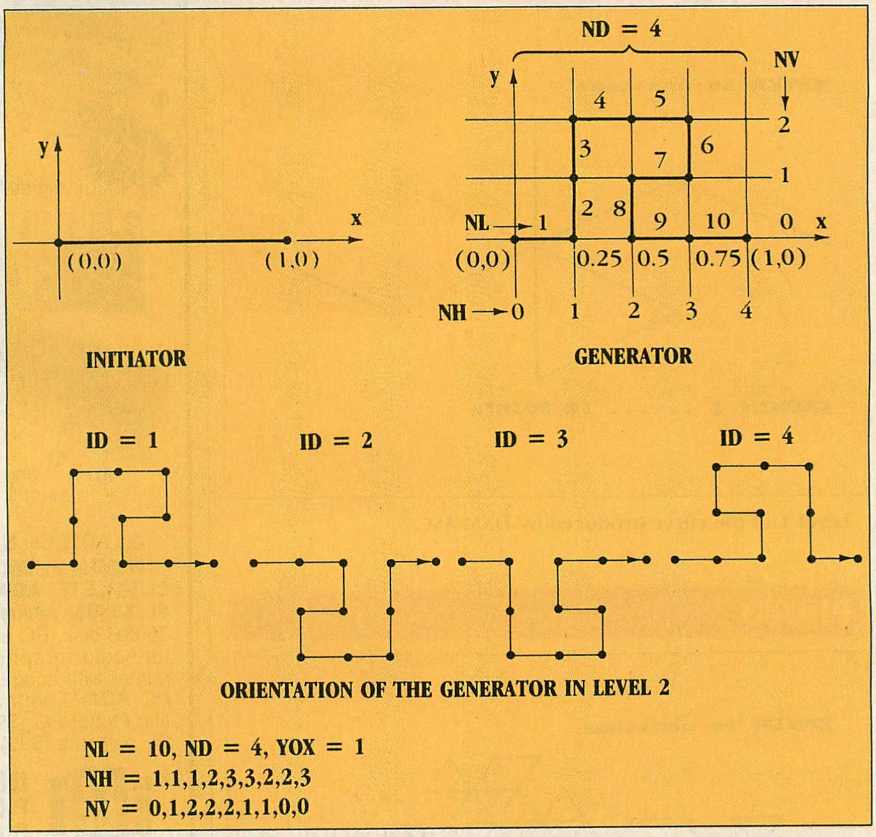
Each line is replaced by the figure in photo 1.

PHOTO 3: *Pinwheel, Level 3*



This figure can also be produced by AEM.ASC.

FIGURE 2: *AEM Nomenclature*



The various terms that are used to describe and manipulate a fractal curve using the array expansion method are explained above.

The DAM uses angles and nested loops in order to draw a fractal curve. The program's first step (lines 70-100) is to input several elements: the number of line segments in the generator (NL), the length of a line segment (DL, based on the initiator of length 1), the unit angle in degrees (AU), and the angles of each line segment in multiples of the unit angle with respect to the positive x axis (A(i)). After the x and y ranges are set up, the main routine begins (lines 200-470).

Level 1 is the generator itself, drawn as specified by the input (lines 340-360). For level 2, the angle of the first line segment in level 1 is added to the angles of each line segment in the generator, and this line segment is replaced by the smaller generator (the length is equal to DL^2). The second line segment is replaced using the same procedure (adding the angle of this line segment to the angles of the line segments in the generator and drawing the same reduced size generator with these new angles). This process continues until the last line segment is replaced with the reduced size generator. For level 3 and higher, this same operation is performed, with the generator further reduced in size (for example, the length of a line segment in level 3 is DL^3).

The DAM program is simple to understand but limited. When the line segments in the generator are of different lengths or the orientation of the generator is not uniform (for example, the generating shape in level 2 can be upside down or even reversed), this program can no longer handle it properly.

ARRAY EXPANSION METHOD

This method (abbreviated to AEM) requires considerably more memory than the DAM, because all the x and y coordinate values at any given level must be stored; the method is thus recommended for computers that have more than 64KB of RAM. It also takes a little longer to draw a fractal curve using this method than it does using the direct angle method (see table 1). However, the AEM can handle fractal curves that have generators with unequal-length line segments. In addition, the generator can be oriented differently at different levels, and curved line segments can be used as part of the generator (provided that a separate subroutine to connect two adjacent points in the generator is provided).

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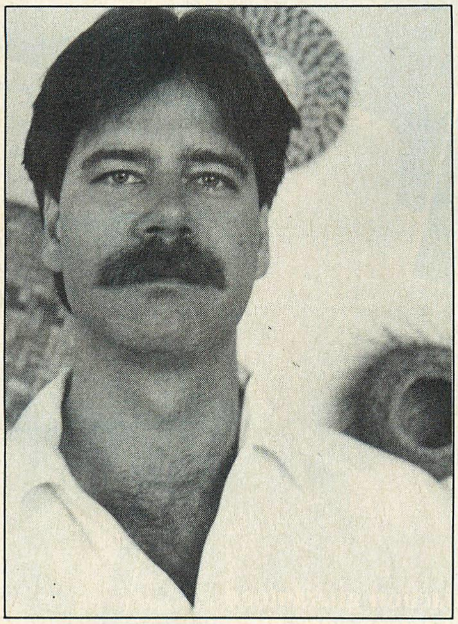

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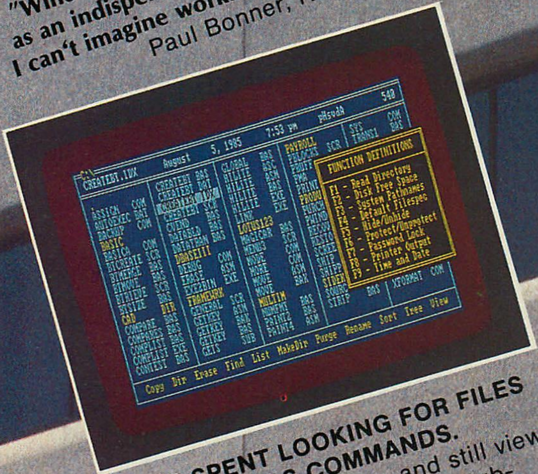

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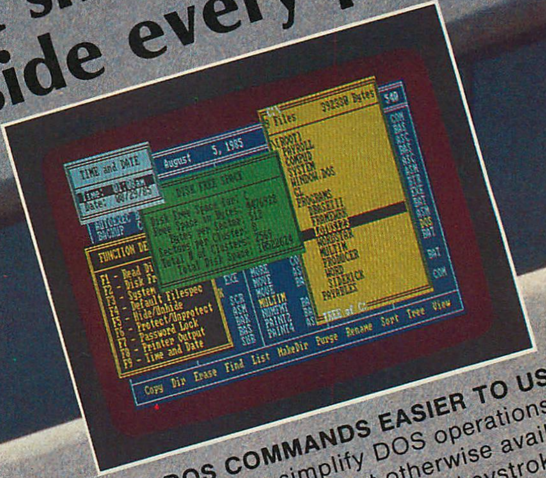

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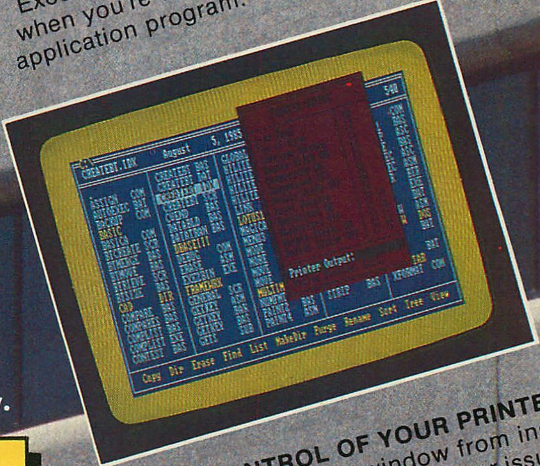

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Batch file copy or erase	Yes	No	Yes	Yes	Yes	No
Change file attributes	Yes	No	No	Yes	No	Yes
Change default subdirectory	Yes	No	Yes	No	Yes	Yes
Create new subdirectories	Yes	No	Yes	Yes	Yes	No
Display Visual TREE	Yes	No	No	Yes	No	No
Check free space on drive	Yes	No	Yes	Yes	Yes	Yes
Display file in ASCII format	Yes	No	Yes	Yes	Yes	Yes
Display file in HEX format	Yes	No	No	Yes	No	Yes
Check or set time and date	Yes	No	Yes	No	Yes	Yes
Send printer control codes	Yes	No	No	No	No	No
Select default printer	Yes	No	No	No	No	No
Password "lock" computer	Yes	No	No	No	No	No
Screen timeout feature	Yes	No	Yes	No	No	No
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PHOTO 4: *Sausage Link, Level 1*

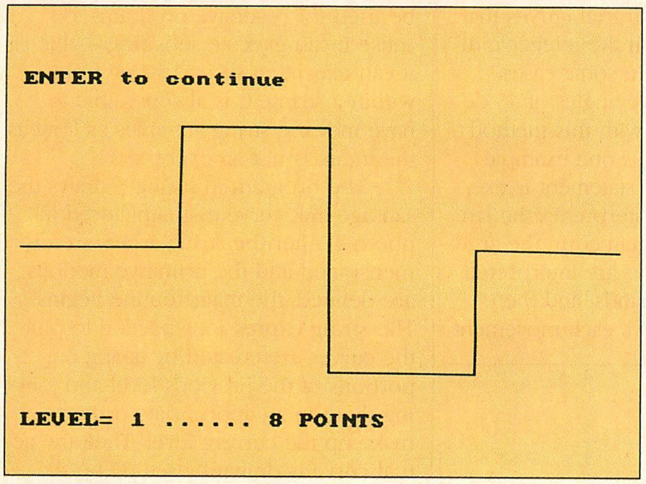
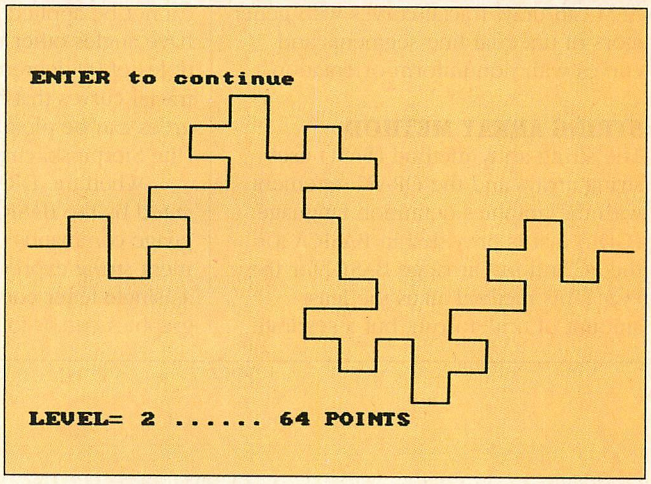


PHOTO 5: *Sausage Link, Level 2*



These are the first two levels of the sausage-link fractal curve, which can be drawn by any of the described methods. It provides a means of benchmarking the performance of fractal-curve-drawing algorithms as summarized in table 1.

Listing 2 is a BASIC program that uses the array expansion method. The main routine calls three subroutines in order to complete the coordinate and orientation arrays. Additional variables that are used in describing the generator are as follows (see figure 2 for explanations of the nomenclature):

ND—number of divisions
YOX—scale of a y division with respect to x division
NH(i)—horizontal position of the connecting points
NV(i)—vertical position of the connecting points
ID(i)—orientation of the generator in levels other than level 1

The variables SC (screen size) and IP (the choice of the vertical position of the initiator) are used in the same way as they were in the DAM.

After the input parameters are read in and the curve is positioned, x and y coordinate arrays are initialized (lines 240 and 250). In the main routine of the AEM program (lines 270-390), three calls to subroutines must be made before the actual curve is plotted.

The first subroutine (lines 430-480) expands x and y coordinate arrays so that the necessary points corresponding to the number of line segments in the generator can be inserted between the two adjacent points in the previous level. The second subroutine (lines 500-700) calculates the x and y coordinate values of the generator at the current level, which fills up the expanded x and y arrays based on the two endpoints and the orientation of the previous line segment. Another call (lines 930-1010) finds the angle of the line segment with respect to the positive x axis in the range from 0 to 2 * *Pi* radians.

The third and last subroutine (lines 720-910) expands the orientation array for the next level in the same way that x and y arrays were expanded.

TABLE 1: *Benchmarks*

LEVEL	TIME (in seconds) DAM	AEM	SAM
1	2	12	2
2	8	19	3
3	51	70	7
4	398	471	31

Above is the time (in seconds) that each of the three methods required to draw the sausage-link curve shown in photo 4 to the level specified.

In addition to the curves shown in photos 1, 2, and 3 and figure 1, the AEM can draw fractal curves with generators of unequal line segments and curves with nonuniform orientation.

STRING ARRAY METHOD

The string array method (SAM) uses string arrays and the DRAW statement with the graphics definition language (GDL) that is provided in BASICA for the PC and in Cartridge BASIC for the PC*jr*. This method takes the least amount of time to run, but a separate program must be written for each fractal curve. Furthermore, this method cannot be applied to fractal curves that have angles other than the integer multiples of 90 degrees. In some cases, fractal curves that have angles of 45 degrees can be plotted with this method (the Sierpinski curve is one example).

When the DRAW statement is executed by the BASIC interpreter, the language commands contained in the argument string expression are interpreted as single-letter commands, and the graphics cursor follows each movement command and draws the picture. The single-letter command X in the GDL can be used for recursive programs, because it can execute substrings—that is, it can execute a second string from within a string. It is also possible to have indexed string variables as long as the index is not an expression.

The program in listing 3 draws the sausage-link curve that is pictured in photo 4. After the string arrays are dimensioned and the primitive motions are defined, the main routine begins. The string expressions needed to plot the curves are created by taking out portions of the previous level and joining them in an appropriate order to make up the current level. Then the actual curve is drawn by setting up the correct scale, moving to the starting point, and finally executing the single DRAW statement (lines 280-370).

BENCHMARKS

To measure the speed of these three methods, each of them was used to draw the sausage-link curve shown in photo 4. Table 1 shows the time (in seconds) that it took each method to draw the given curve to the specified level. For example, SAM took only 7 seconds to draw levels 1, 2, and 3 of the sausage-link curve.

As the table shows, SAM is the fastest method and AEM is the slowest. Considering how many more calculations it must perform, however, AEM performs rather well. In addition, all fractal curves can be handled by this method. For example, the program in listing 1 can be modified to include the orientation "0" for the unconnected line segments in the generator or a separate subprogram can be provided to connect two adjacent points with a curve rather than just a straight line.

If the data points in listing 1, 2, and 3 are changed, these programs can be used to create many different types of fractal curves on the IBM PC.

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Peitgen, H. O., D. Saupe, and F. V. Haeseler. "Cayley's Problem and Julia Sets," *The Mathematical Intelligencer*, vol. 6, no. 2 (1984):11-20.

Peterson, Ivars. "Escape into Chaos," *Science News* (May 26, 1984):328-29.

Sorensen, Peter. "Fractals," *Byte* (September 1984):157-72.

LISTING 1: DAM.ASC

```
20 ' FRACTAL CURVE                    DAM
30 '---------------------------------
40  CLS:KEY OFF:OPTION BASE 1
50  SCREEN 1,1:DEFINT I-R
60 '----- INPUT PARAMETERS -----------
70  RESTORE 550
80  READ NL,DL,AU,SC,IP
90  DIM A(NL):FOR I=1 TO NL:READ A(I)
100 A(I)=A(I)*AU*3.141593/180:NEXT I
110 '----- POSITION THE CURVE --------
120 XMAX=.5+SC*.5:XMIN=.5-SC*.5
130 ON IP GOTO 150,160,170
140 PRINT "IP>3":END
150 YMAX=.36*SC:YMIN=-.36*SC:GOTO 180
160 YMAX=.54*SC:YMIN=-.18*SC:GOTO 180
170 YMAX=.6*SC:YMIN=-.12*SC
180 VIEW:WINDOW (XMIN,YMIN)-(XMAX,YMAX)
190 '----- MAIN ROUTINE --------------
200 FOR LEVEL=1 TO 4:CLS
210 LOCATE 25,1:PRINT "LEVEL=";LEVEL;
220 XL=DL^LEVEL:NT=NL^LEVEL
230 PRINT "......";NT;"POINTS"
240 PSET(0,0):X=0:Y=0:N=0
250 IF LEVEL=1 THEN BAT=0:GOTO 350
260 FOR I1=1 TO NL:BA(1)=A(I1)
270 IF LEVEL=2 THEN 330
280 FOR I2=1 TO NL:BA(2)=A(I2)
290 IF LEVEL=3 THEN 330
300 FOR I3=1 TO NL:BA(3)=A(I3)
310 IF LEVEL=4 THEN 330
320 FOR I4=1 TO NL:BA(4)=A(I4)
330 BAT=0:FOR K=1 TO LEVEL
340 BAT=BAT+BA(K):NEXT K
350 FOR J=1 TO NL:CA=BAT+A(J)
360 X=X+XL*COS(CA):Y=Y+XL*SIN(CA)
370 N=N+1:LINE -(X,Y):NEXT J
380 IF N=NT THEN 450
390 ON LEVEL GOTO 450,430,420,410,400
400 NEXT I4
410 NEXT I3
420 NEXT I2
430 NEXT I1
440 '----- CONTINUE? -----------------
450 LOCATE 1,1
460 PRINT "ENTER to continue";
470 I$=INKEY$:IF I$="" THEN 450
480 IF I$=CHR$(13) THEN NEXT LEVEL
490 END
500 '----- END PROGRAM ---------------
510 '                        SAUSAGE LINK
520 DATA 8,.25,90,1,1
530 DATA 0,1,0,-1,-1,0,1,0
540 '                           PINWHEEL
550 DATA 10,.2886751,30,1,1
560 DATA 1,-1,3,-1,-5,-5,-1,3,-1,1
570 '                          ARROWHEAD
580 DATA 10,.25,60,1,1
590 DATA 0,0,2,0,-1,-3,-2,0,1,0
600 '              HEXAGONAL CONNECTION
610 DATA 10,.25,60,1,1
620 DATA 0,1,0,-1,3,3,-1,0,1,0
630 '
640 '----- END DATA ------------------
```

LISTING 2: AEM.ASC

```
20 ' FRACTAL CURVES                   AEM
30 '---------------------------------
40  CLS:SCREEN 1,1:OPTION BASE 1
50  KEY OFF:DEFINT I-N:PI=3.141593
60  LOCATE 12,17:PRINT "Wait..."
70  DIM NH(50),NV(50),ID(50)
80  NM=5000:DIM X(NM),Y(NM),IC(NM)
90 '----- INPUT PARAMETERS -----------
100 RESTORE 1040
110 READ NL,ND,YOX,SC,IP
120 FOR I=1 TO NL-1:READ NH(I):NEXT
```

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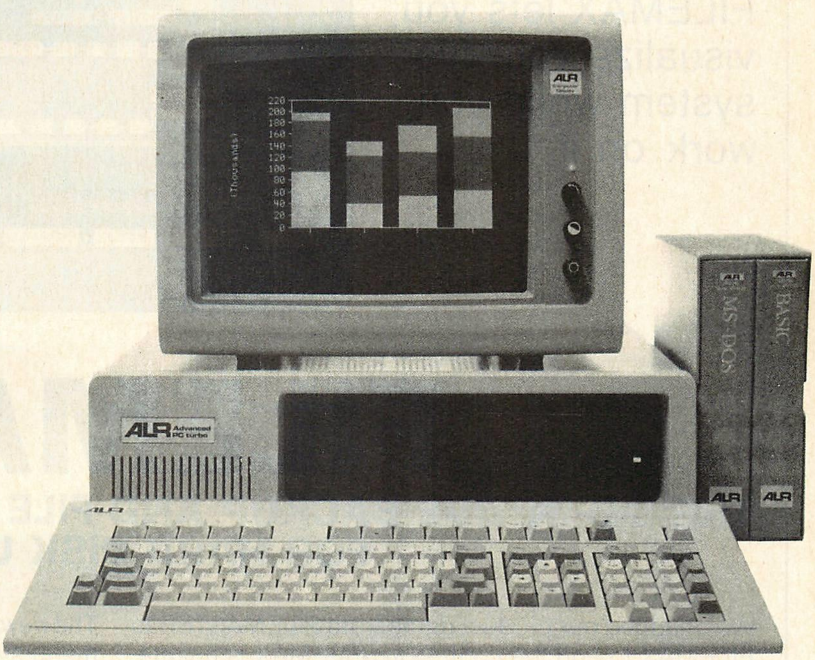

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```
130 FOR I=1 TO NL-1:READ NV(I):NEXT
140 FOR I=1 TO NL  :READ ID(I):NEXT
150 '----- POSITION THE CURVE ---------
160 XMIN=.5-.5*SC:XMAX=.5+.5*SC
170 ON IP GOTO 190,200,210
180 PRINT "IP>3":END
190 YMAX=.36*SC:YMIN=-.36*SC:GOTO 220
200 YMAX=.54*SC:YMIN=-.18*SC:GOTO 220
210 YMAX=.6*SC :YMIN=-.12*SC
220 VIEW:WINDOW (XMIN,YMIN)-(XMAX,YMAX)
230 '----- INITIALIZE ----------------
240 DIM ICT(1):IC(1)=1:LAST=2
250 X(1)=0!:X(2)=1!:Y(1)=0!:Y(2)=0!
260 '----- MAIN ROUTINE --------------
270 FOR LEVEL=1 TO 4:CLS
280 LOCATE 25,1:PRINT "LEVEL =";LEVEL;
290 NNEW=(LAST-1)*NL+1:GOSUB 430
300 GOSUB 500:LAST=NNEW
310 IF LEVEL<5 THEN GOSUB 720
320 '----- DRAW THE CURVE ------------
330 PSET (X(1),Y(1)):FOR IP=2 TO LAST
340 LINE -(X(IP),Y(IP)):NEXT IP
350 '----- CONTINUE? -----------------
360 LOCATE 1,1
370 PRINT "ENTER to continue";
380 I$=INKEY$:IF I$="" THEN 360
390 IF I$=CHR$(13) THEN NEXT LEVEL
400 END
410 '----- END PROGRAM ---------------
420 '----- EXPAND X AND Y ARRAYS ------
430 IF NNEW<NM THEN 450
440 PRINT "...... MEMORY OVERFLOW":END
450 PRINT "......";NNEW;"POINTS"
460 FOR I=1 TO LAST:IFROM=LAST-I+1
470 ITO=(IFROM-1)*NL+1:X(ITO)=X(IFROM)
480 Y(ITO)=Y(IFROM):NEXT I:     RETURN
490 '----- GENERATING FUNCTION --------
500 FOR I=2 TO LAST:II=(I-2)*NL+1
510 XS=X(II):YS=Y(II) :XF=X(II+NL)
520 YF=Y(II+NL):GOSUB 930
530 DX=(XF-XS)/ND:DY=(YF-YS)/ND
540 D=SQR(DX^2+DY^2):S=SIN(T):C=COS(T)
550 FOR J=1 TO NL-1:K=II+J:L=NL-J
560 ON IC(I-1) GOTO 570,600,640,670
570 X(K)=(XS+DX*NH(J))-D*YOX*NV(J)*S
580 Y(K)=(YS+DY*NH(J))+D*YOX*NV(J)*C
590 GOTO 700
600 NDH=ND-NH(L)
610 X(K)=(XS+DX*NDH)+D*YOX*NV(L)*S
620 Y(K)=(YS+DY*NDH)-D*YOX*NV(L)*C
630 GOTO 700
640 X(K)=(XS+DX*NH(J))+D*YOX*NV(J)*S
650 Y(K)=(YS+DY*NH(J))-D*YOX*NV(J)*C
660 GOTO 700
670 NDH=ND-NH(L)
680 X(K)=(XS+DX*NDH)-D*YOX*NV(L)*S
690 Y(K)=(YS+DY*NDH)+D*YOX*NV(L)*C
700 NEXT J:NEXT I:             RETURN
710 '----- EXPAND IC ARRAY ------------
720 NUM=NL^(LEVEL-1)
730 ERASE ICT:  DIM ICT(NUM)
740 FOR I=1 TO NUM:ICT(I)=IC(I):NEXT
750 FOR I=1 TO NUM
760 ON ICT(I) GOTO 770,790,840,890
770 FOR J=1 TO NL:K=NL*(I-1)+J
780 IC(K)=ID(J):NEXT J:        GOTO 910
790 FOR J=1 TO NL:K=NL*(I-1)+J
800 ON ID(NL-J+1) GOTO 810,810,820,820
810 IC(K)=3-ID(NL-J+1):GOTO 830
820 IC(K)=7-ID(NL-J+1)
830 NEXT J:                    GOTO 910
840 FOR J=1 TO NL:K=NL*(I-1)+J
850 ON ID(J) GOTO 860,860,870,870
860 IC(K)=ID(J)+2:GOTO 880
870 IC(K)=ID(J)-2
880 NEXT J:                    GOTO 910
890 FOR J=1 TO NL:K=NL*(I-1)+J
900 IC(K)=5-ID(NL-J+1):NEXT J
```


CIRCLE NO. 200 ON READER SERVICE CARD

```
910 NEXT I:                          RETURN
920 '----- FIND ANGLE WRT +X AXIS -----
930 DX=XF-XS:DY=YF-YS
940 IF DX=0 THEN 990
950 T=ATN(DY/DX)
960 IF DX<0! THEN 1000
970 IF DY<0! THEN T=T+PI*2
980 GOTO 1010
990 T=PI/2:IF DY>=0! THEN 1010
1000 T=T+PI
1010 RETURN
1020 '----- DATA ---------------------
1030 '                    SAUSAGE LINK
1040  DATA 8,4,1,1,1
1050  DATA 1,1,2,2,2,3,3
1060  DATA 0,1,1,0,-1,-1,0
1070  DATA 1,1,1,1,1,1,1,1
1080 '                        PINWHEEL
1090  DATA 10,4,0.57735,1,1
1100  DATA 1,2,2,3,2,1,2,2,3
1110  DATA 1,0,2,1,0,-1,-2,0,-1
1120  DATA 1,1,1,1,1,1,1,1,1,1
1130 '                       ARROWHEAD
1140  DATA 10,8,1.732051,1,1
1150  DATA 2,4,3,5,6,4,3,5,6
1160  DATA 0,0,1,1,0,0,-1,-1,0
1170  DATA 1,1,1,1,1,1,1,1,1,1
1180 '           HEXAGONAL CONNECTION
1190  DATA 10,8,1.732051,1,1
1200  DATA 2,3,5,6,4,2,3,5,6
1210  DATA 0,1,1,0,0,0,-1,-1,0
1220  DATA 1,1,1,1,1,1,1,1,1,1
1230 '                   SHOGUN HELMET
1240  DATA 4,4,1.73205,1,2
1250  DATA 1,2,3,0,1,0,1,1,1,1
1260 '                     MONKEY TREE
1270  DATA 7,6,1.732051,1.8,2
1280  DATA 1,2,4,5,2,4,1,2,2,1,0,0
1290  DATA 3,1,1,4,2,2,1
1300 '----- END DATA -----------------
```

LISTING 3: SAM.ASC

```
20 ' FRACTAL CURVE                    SAM
30 '---------------------------------
40  SCREEN 1,1:KEY OFF:CLS
50  LOCATE 12,17:PRINT "Wait..."
60 '----- DIMENSIONS -----------------
70  DIM U$(5),D$(5),R$(5),L$(5)
80 '----- PRIMITIVE MOTIONS ---------
90  U$(0)="U2":D$(0)="D2"
100 R$(0)="R2":L$(0)="L2"
110 '----- CREATE CURVE -------------
120 FOR K=1 TO 4
130 MU$="XU$("+STR$(K-1)+");"
140 MD$="XD$("+STR$(K-1)+");"
150 MR$="XR$("+STR$(K-1)+");"
160 ML$="XL$("+STR$(K-1)+");"
170 '----- LEVEL CHANGERS ------------
180 MU2$=MU$+MU$
190 MD2$=MD$+MD$
200 MR2$=MR$+MR$
210 ML2$=ML$+ML$
220 U$(K)=MU$+ML$+MU$+MR2$+MU$+ML$+MU$
230 D$(K)=MD$+MR$+MD$+ML2$+MD$+MR$+MD$
240 R$(K)=MR$+MU$+MR$+MD2$+MR$+MU$+MR$
250 L$(K)=ML$+MD$+ML$+MU2$+ML$+MD$+ML$
260 NEXT K
270 '----- DRAW THE CURVE ------------
280 FOR K=1 TO 4:CLS
290 SIDE=4^K:SCALE=500/SIDE
300 LOCATE 25,1:PRINT "LEVEL =";K
310 DRAW "BM20,100;S=SCALE;"
320 DRAW R$(K)
330 '----- CONTINUE? -----------------
340 LOCATE 1,1
350 PRINT "ENTER to continue";
360 I$=INKEY$:IF I$="" THEN 340
370 IF I$=CHR$(13) THEN NEXT K
380 END
390 '----- END PROGRAM ---------------
```

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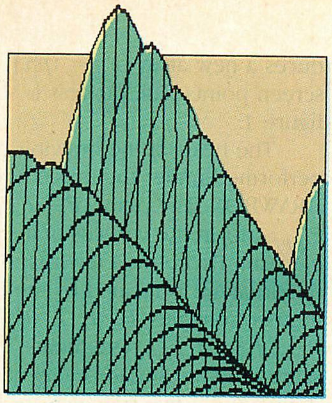


The Painter's Algorithm

RICHARD CHANDLER and GARY FAULKNER

Using a variant of this algorithm, programmers may be able to eliminate the hidden lines in three-dimensional objects rendered by a computer.

Considerable energy has been spent over the past few years developing ways for computers to render three dimensional objects. Such procedures often contain some form of a hidden line or hidden surface algorithm that confronts the problem that portions of a computer-generated object, once rendered, may occlude other objects or other portions of itself.

An algorithm intended to satisfy this consideration would require much computer time and memory and would be incredibly complex. The process can be simplified, however, if advantage is taken of the special properties of the surfaces being rendered.

The case chosen for discussion here is one frequently encountered in university mathematics courses. It involves the surface determined by the graph of a function of two independent variables (the graph of $z = f(x,y)$). This equation predetermines the visual priority of the surface elements, and no depth sorting is necessary.

In graph form, the domain of this function is a rectangle that is divided into a grid of smaller rectangles. The values of the function, computed at the vertices of these small rectangles, produce an array of points (x_i, y_j, and z_{ij}) on the surface of the rectangle. By using line segments to connect the points at adjacent vertices, a new surface of polygons is drawn. The natural ordering of the points at the vertices corresponds directly to the depth priority of each new surface element. Elements further from the viewer will be drawn to indices with relatively smaller values. Likewise, elements that appear closer to the viewer will be drawn to indices with higher values.

In other words, surface elements are drawn in order from background to foreground. If a foreground element overlaps a background element the picture becomes visually confusing, and conflicting lines must be removed. This is accomplished using a variant of the Painter's Algorithm in which the interior of the nearer element is filled with the screen background color, thereby eliminating any hidden lines. The procedure is analogous to that of an artist who paints foreground objects over background objects to eliminate any problem of hidden lines.

This process is made possible with the help of a program that is actually a series of calls to other procedures, each of which is explained below. The program (see the listing) was written for use with the Turbo Pascal compiler (version 2.0) and, because it incorporates much floating point arithmetic, is recommended for use with the 8087 math coprocesser.

To allow for easy modification, the first item in the program is the definition of the function to be graphed. The constant declaration portion that follows contains two sets of parameters intended for specification by the user. The values of *xdiv* and *ydiv* determine the number of subdivisions in the domains of x and y, respectively. Smaller values assigned to these variables would result in programs that run faster but sacrifice the quality of the surface resolution. If the surface of the function varies considerably over the region of interest, a larger number of subdivisions should be used in order to maintain some degree of quality in resolution.

The three variables xeye, yeye, and zeye indicate the eye position from which the surface is viewed. Because the application of the Painter's Algorithm used in this example proceeds with increasing x and y, xeye and yeye

should both be positive. Unpredictable results may occur if the eye position is within the region where the surface is actually being plotted; therefore, at least one of the two variables xeye and yeye should be greater than the maximum value of the corresponding x and y variables. Zeye may be chosen arbitrarily; positive values give a view of the surface from above, negative values give a view from below.

Procedures INPUT_DOMAIN and SWAP are self-explanatory. EVALUATE_AND_PROJECT creates the grid of small rectangles within the surface being rendered, evaluates the function at the vertices of these rectangles, and, finally, projects the corresponding points onto the viewing plane from the perspective of the eye position. The viewing plane contains the origin, is parallel to the z axis, and is perpendicular to the line drawn through the eye position and the center of the function's domain. The procedures FIND_EXTREMA and SCALE_ TO_SCREEN scale the resulting array of projected points (y[i, j], z[i, j]) to fit the size of the screen. This produces a new array ($P_{i,j}$ = (p[i,j], q[i,j]) of screen points. The process is shown in figure 1.

The heart of the drawing process is performed under the procedure called DRAWBOX. The points $P_{i,j}$, $P_{i+1,j}$, $P_{i,j+1}$, $P_{i+1,j+1}$ form the vertices of a surface element. Except in a few cases, this quadrilateral is formed by the union of the two triangles, $P_{i,j}$, $P_{i+1,j}$, $P_{i,j+1}$ and $P_{i+1,j}$, $P_{i,j+1}$, $P_{i+1,j+1}$ (see figure 2). At the same time the surface element is being drawn, these two triangles are filled with the background color of the screen by the procedure TRIBLANK (which is called into operations by DRAWBOX). This removes any lines that the surface element has hidden.

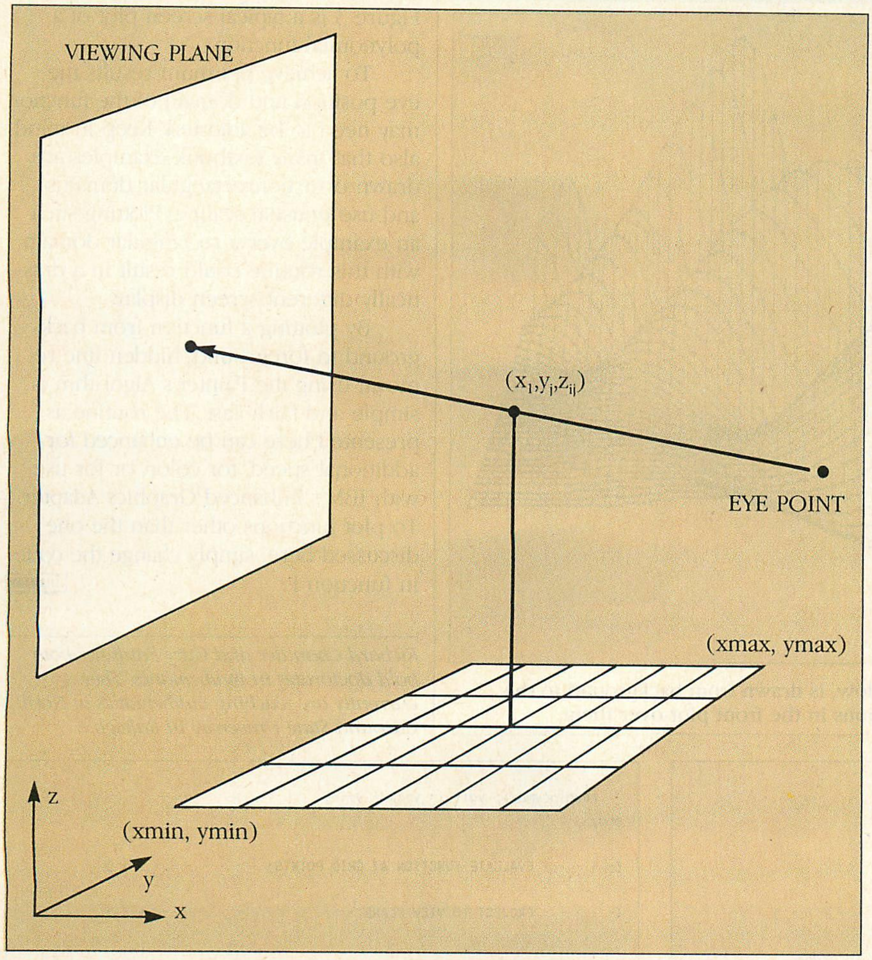
Because of the difficulty involved with consistently finding the seed point within the region to be filled, a seed fill algorithm (such as BASIC's PAINT) is unsatisfactory for use in this case. Each triangle may be filled easily and quickly by simply drawing a series of horizontal lines from the top vertex to the bottom vertex. The endpoints of these lines (the sides of the triangle) can be determined with the help of a version of Bresenham's line algorithm. This algorithm, because it uses only integer arithmetic, is very fast.

The process of actually drawing the horizontal line is accomplished by the procedure LINE, a short, in-line machine-language routine. The two endpoints, as well as the y figure giving the scanline on which the line must be drawn, are passed to LINE, which begins at one endpoint and continues by repeatedly calling ROM VIDEO (software interrupt 10H). This procedure resets the pixel at x,y for each successive x value, thus moving constantly forward toward the opposite endpoint. Any case that is inaccurately filled will remain invisible unless the resolution is coarse. After its interior is filled with the color of the background, the boundary of each surface element is drawn by using line segments to connect its vertices.

LINE is written in machine language for purposes of speed only; if the procedure were rewritten to bypass ROM VIDEO and write directly to screen memory, the plot would progress even more quickly.

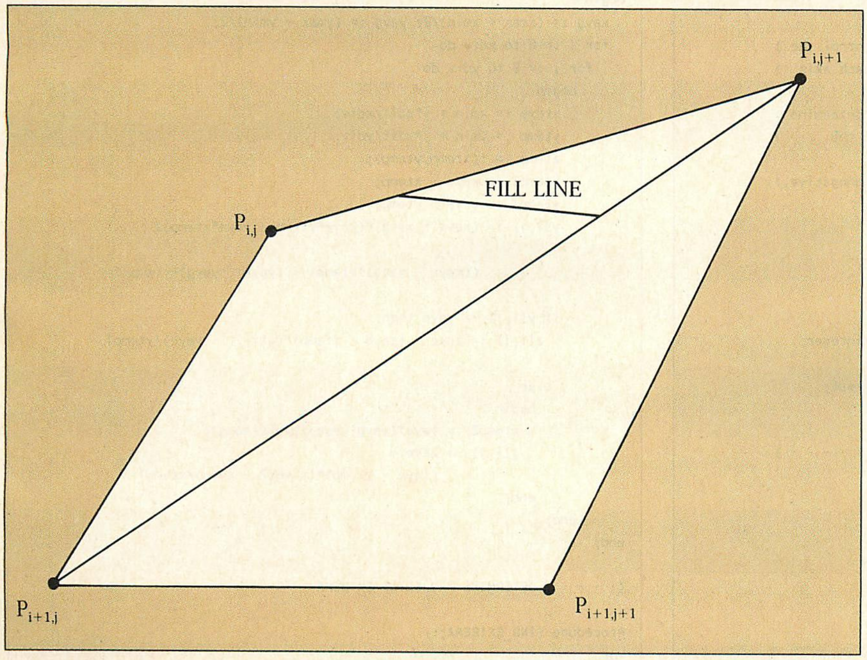
Using Turbo Pascal and the 8087 coprocessor, the program required slightly more than two minutes to complete the graph of a moderately complicated transcendental function; however, it took more than eight minutes for the same task without the 8087. Most of this time differential is consumed by EVALUATE_AND_PROJECT. Without the

FIGURE 1: *Procedure EVALUATE_AND_PROJECT*



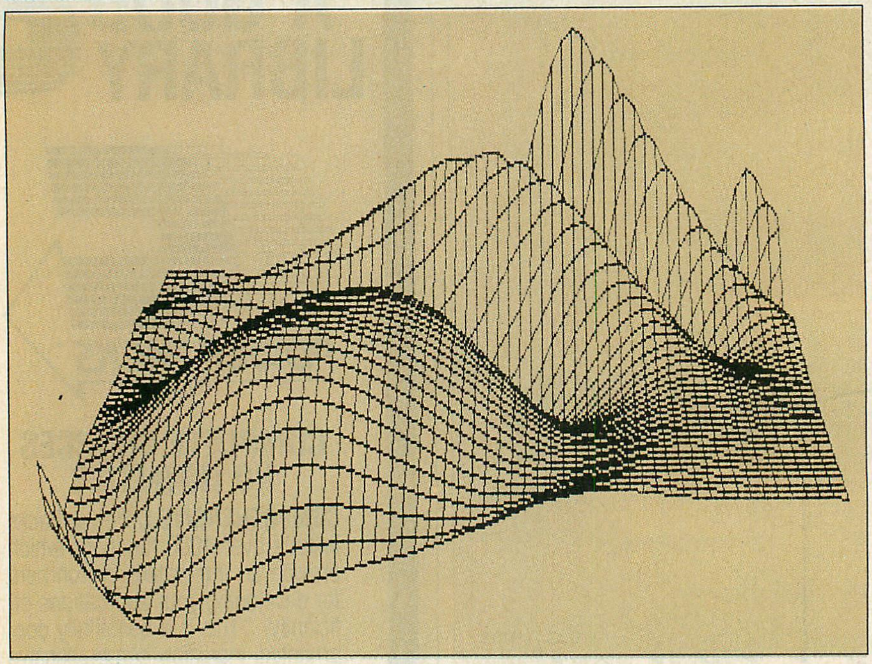
Procedure EVALUATE_AND_PROJECT first calculates point coordinates for the plotted function and then projects the points onto a viewing plane.

FIGURE 2: *Surface Element*



Quadrilaterals in the plotted figure are filled by treating them as two triangles and filling each of the triangles with blank horizontal lines.

FIGURE 3: *Typical Screen Plot*



The plot, generated from SURFACE.PAS below, is drawn from background to the foreground, so that lines are hidden as regions in the front plot over them.

coprocesser, actual screen graphing will not begin for six or seven minutes. Figure 3 is a typical screen plot of a polynomial function.

To achieve optimum results the eye position and domain of the function may need to be adjusted. Keep in mind also that many textbook examples are drawn over nonrectangular domains and use unusual scaling. Plotting such an example over a rectangular domain with this routine could result in a drastically different screen display.

By plotting a function from background to foreground, hidden line removal using the Painter's Algorithm is simple and fairly fast. The routine as presented here can be enhanced for additional speed, for color, or for use with IBM's Enhanced Graphics Adapter. To plot functions other than the one discussed here, simply change the code in function F.

Richard Chandler and Gary Faulkner both hold doctorates in mathematics. They currently are teaching mathematics at North Carolina State University in Raleigh.

LISTING: SURFACE.PAS

```
Program SURFACE;


{- - - - - DEFINE FUNCTION TO BE GRAPHED - - - - - - - - - - - - }

Function f(x,y:real):real;      { Change this entry in order  }
begin                           {  to graph another function. }
  f := exp(-(x*y+y*y)/90)*cos((x*x+y*y)/40);
end;

{- - - - - DECLARATIONS- - - - - - - - - - - - - - - - - - - - - }

const
   xdiv = 40;          {* * * These two constants control the }
   ydiv = 60;          { number of subdivisions of each axis  }

   xeye = 100;         {* * * These three constants determine }
   yeye = 10;          { the eye position from which the      }
   zeye = 8;           { surface is viewed. }
                   { NOTE : xeye and yeye should be nonnegative.}

var
   i, j                :    integer;
   xmax, xmin, ymax    :    real;
   ymin, zmax, zmin    :    real;
   xdif, ydif, zdif    :    real;
   p, q                :    array[0..xdiv,0..ydiv] of integer;

   y, z                :    array[0..xdiv,0..ydiv] of real;


{- - - - - INPUT EXTREME VALUES FOR X, Y - - - - - - - - - - - - }

Procedure INPUT_DOMAIN;
begin
   write('Enter smallest value of x  ');
   readln(xmin);
   write('Enter  largest value of x  ');
   readln(xmax); xdif := xmax - xmin;
   write('Enter smallest value of y  ');
   readln(ymin);
   write('Enter  largest value of y  ');
   readln(ymax); ydif := ymax - ymin;
end;

{- - - - - EVALUATE FUNCTION AT GRID POINTS; - - - - - - - - - - }

{- - - - - PROJECT TO VIEW PLANE - - - - - - - - - - - - - - - - }


Procedure EVALUATE_AND_PROJECT;
var
   xtemp,xtemp1,xtemp2,ytemp,ytemp1,ztemp,xavg,yavg  :  real;


begin
  xavg := (xmax + xmin)/2; yavg := (ymax + ymin)/2;
  for i := 0 to xdiv do
    for j := 0 to ydiv do
      begin
        xtemp := xmin + i*xdif/xdiv;
        ytemp := ymin + j*ydif/ydiv;
        ztemp := f(xtemp,ytemp);
        xtemp1 := xeye - xtemp;
        ytemp1 := yeye - ytemp;
        y[i,j] := (xeye - xavg)*(xeye*ytemp - yeye*xtemp)/

                   ((xeye - xavg)*xtemp1 + (yeye - yavg)*ytemp1);

        if y[i,j] <> yeye then
          z[i,j] := zeye + (zeye - ztemp)*(y[i,j] - yeye)/ytemp1

         else
           begin
             xtemp2 := yeye*(yavg-yeye)/(xeye-xavg);
             z[i,j] := zeye +
                       (zeye - ztemp)*(xtemp2 - xeye)/xtemp1
           end;
      end;
end;

{- - - - - DETERMINE PROJECTED EXTREMA - - - - - - - - - - - - - }

Procedure FIND_EXTREMA;
var
   ytemp,ztemp  :  real;
```

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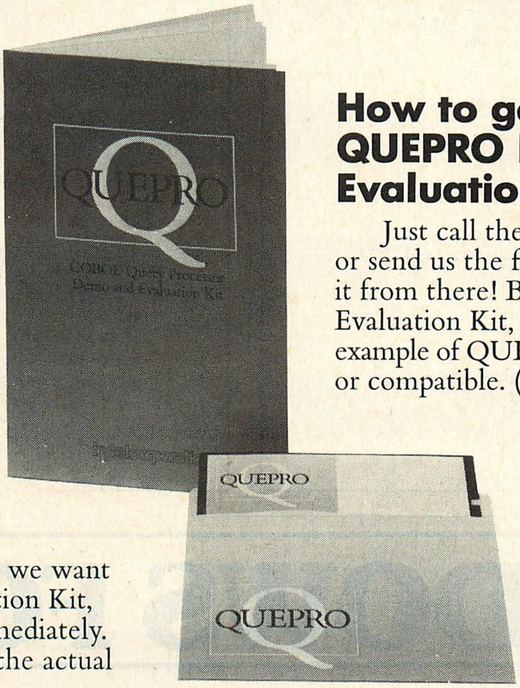

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```
begin
  ymax := y[0,0]; ymin := ymax;
  zmax := z[0,0]; zmin := zmax;
  for i := 0 to xdiv do
    for j := 0 to ydiv do
    begin
      ytemp := y[i,j]; ztemp := z[i,j];
      if ytemp > ymax then ymax := ytemp;
      if ytemp < ymin then ymin := ytemp;
      if ztemp > zmax then zmax := ztemp;
      if ztemp < zmin then zmin := ztemp;
    end;
end;

{- - - - - SCALE TO SCREEN - - - - - - - - - - - - - - - - - - }

Procedure SCALE_TO_SCREEN;
var
  dy,dz  :  real;
begin
  dy := (ymax - ymin)/639; dz := (zmax - zmin)/199;
  for i := 0 to xdiv do
    for j := 0 to ydiv do
    begin
      p[i,j] := round((y[i,j] - ymin)/dy);
      q[i,j] := 199 - round((z[i,j] - zmin)/dz);
    end;
end;

{- - - - - EXCHANGE COORDINATES OF TWO POINTS- - - - - - - - - }

Procedure SWAP(var x1,y1,x2,y2:integer);
var
  temp : integer;
begin
  temp := x1; x1 := x2; x2 := temp;
  temp := y1; y1 := y2; y2 := temp;
end;
```

```
{- - - - - DRAWS BLANK HORIRONTAL LINE - - - - - - - - - - - - - }

Procedure LINE(x0,x1,y:integer);
begin
  inline($8B/$BE/x1/                 {MOV DI,x1}
         $8B/$8E/x0/                 {MOV CX,x0}
         $39/$CF/                    {CMP DI,CX}
         $7D/$02/                    {JGE 2 bytes}
         $87/$F9/                    {XCHG CX,DI}
         $8B/$96/y/                  {MOV DX,y }
         $BB/$00/$0C/                {MOV BX,0C00}
         $89/$D8/                    {L1: MOV AX,BX}
         $CD/$10/                    {INT 10H}
         $41/                        {INC CX}
         $3B/$F9/                    {CMP DI,CX}
         $7D/$F7);                   {JG L1}
end;

{- - - - - BLANKS TRIANGLE - - - - - - - - - - - - - - - - - - }


Procedure TRIBLANK(x0,y0,x1,y1,x2,y2:integer);
var
  x3,x4,dx1,dx2,dy1,dy2          :    integer;
  inc1,inc2,nx1,nx2              :    integer;

Procedure BLANK(y:integer);
begin
  while y0 < y do
  begin
    nx1 := nx1 + dx1;
    if nx1 > dy1 then
    repeat
      x3 := x3 + inc1;
      nx1 := nx1 - dy1;
    until nx1 <= dy1;
    nx2 := nx2 + dx2;
```

```
      if nx2 > dy2 then
      repeat
         x4 := x4 + inc2;
         nx2 := nx2 - dy2;
      until nx2 <= dy2;
      y0 := y0 + 1;
      line(x3,x4,y0);
   end;
end;

begin
   if y1 < y0 then swap(x0,y0,x1,y1);
   if y2 < y0 then swap(x0,y0,x2,y2);
   if y2 < y1 then swap(x1,y1,x2,y2);
   dy1 := y1 - y0; dy2 := y2 - y0;
   if x1 < x0 then inc1 := -1 else inc1 := 1;
   if x2 < x0 then inc2 := -1 else inc2 := 1;
   dx1 := abs(x1-x0); dx2 := abs(x2-x0);
   x3 := x0; x4 := x0;
   nx1 := dy1 div 2; nx2 := dy2 div 2;
   blank(y1);
   if x2 < x1 then inc1 := -1 else inc1 := 1;
   x3 := x1; dy1 := y2 - y1;
   dx1 := abs(x1 - x2); nx1 := dy1 div 2;
   blank(y2);
end;

{- - - - - DRAWS BOX WITH BLANK INTERIOR - - - - - - - - - - - - }

Procedure DRAWBOX(x1,y1,x2,y2,x3,y3,x4,y4 : integer);
begin
   triblank(x1,y1,x2,y2,x3,y3);
   triblank(x2,y2,x3,y3,x4,y4);
   draw(x1,y1,x2,y2,1); draw(x1,y1,x3,y3,1);
   draw(x2,y2,x4,y4,1); draw(x3,y3,x4,y4,1);
end;
```

```
{- - - - - DRAWS SURFACE - - - - - - - - - - - - - - - - - - - - }

Procedure GRAPH;
var
   x1,x2,x3,x4,y1,y2,y3,y4   : integer;
begin
   HiRes; HiResColor(10);
   for i := 0 to xdiv-1 do
      for j := 0 to ydiv-1 do
      begin
         x1 := p[i,j];   x2 := p[i+1,j];
         x3 := p[i,j+1]; x4 := p[i+1,j+1];
         y1 := q[i,j];   y2 := q[i+1,j];
         y3 := q[i,j+1]; y4 := q[i+1,j+1];
         drawbox(x1,y1,x2,y2,x3,y3,x4,y4);
      end;
end;

{- - - - - MAIN PROGRAM BEGINS - - - - - - - - - - - - - - - - - }

begin
   input_domain;
   evaluate_and_project;
   find_extrema;
   scale_to_screen;
   graph;
   repeat until keypressed;
   TextMode(3);
end.
```

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```
amort.CFG
6-amrtp
months=months+1;pr=((pmt*12/int)/(1+int/12)
^(mths+1))*[1-(1+int/12)];@next
7-amrti
in=-pmt-((pmt*12/int)/(1+int/12)^(mths+1))
*[1-(1+int/12)];@next
8-sumr
prinpd=prinpd+pr;intpd=intpd+in;mths=mths-1;
@ifqt (mths==168);@goto(6)
```

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Studying Assembly Language

Three books provide three different approaches to learning assembly language; two do the job well.

The 8086/8088 Primer
Second edition, Stephen P. Morse (Hayden Book Company, Rochelle Park, NJ 1982) 276 pages, paper, $18.95

Before registering for my first computer science course that required some knowledge of assembly language, I visited the college bookstore in search of materials to familiarize myself with this language. The most likely sounding title on the course book list was *IBM S/360 Assembler Reference Manual*, but after reading only a few pages I found it totally incomprehensible.

This is not the book with which to begin a study of assembly language; what is needed is a description of the architecture and instruction set of the computer. For IBM mainframers, this information can be found in a volume known as *Principles of Operation*; for PC users, one of the three books reviewed here is often recommended. They are by no means interchangeable, however, and only two of the three truly deserve recommendation.

The 8086/8088 Primer is the best choice for users with no assembly language experience. The introductory material does not insult the reader's intelligence, yet the advanced concepts are presented in such a way as to be accessible to those with only a cursory knowledge of digital logic (bear in mind that assembly language is not for the complete computer novice). In chapter 2 ("8086 Machine Organization"), just when the inexperienced reader is feeling snowed in by the complex machine language encoding of the 8086 instruction set, author Morse comes to the rescue by promising that all those messy details are handled by an assembler and need not be remembered by the programmer. That insight is the first step to successful use of an assembler, but it is seldom mentioned by other references attempting to describe the seeming gobbledygook, such as **mod**, **reg**, and **r/m** fields, of an 8086 machine instruction.

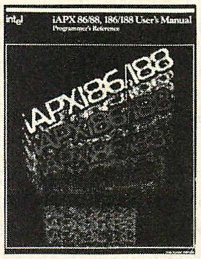
The chapter on instruction sets for the 8086 provides an informal discussion of the instructions according to functional groups. This chapter is not an exhaustive reference, but does provide useful information on the purpose of all instructions, including those for arithmetic with decimal and ASCII digits. It nicely complements the instruction set reference in IBM's assembler manual but is not sufficient for use with Microsoft's documentation, which is merely a list of instruction mnemonics.

The chapter on hardware design is a model of logical exposition. While it may not prepare the reader to construct a PC clone at home, it will help him make sense out of the logic diagrams in the IBM technical reference.

The last three chapters cover programming in assembly language, PL/M (Intel's proprietary high-level language, not available for PC-DOS), and Pascal. Intel's ASM-86 is used to illustrate assembly language programming; since MASM from IBM and Microsoft is a superset of that assembler, the descriptions of the structure and syntax of ASM-86 are directly applicable to MASM and provide much useful information not given in IBM or Microsoft documentation. These chapters merely give the flavor of each high-level language discussed and are meant to pique the reader's interest. A more complete language manual or tutorial is necessary for a thorough understanding.

As one of the principal designers of the 8086 microprocessor, Morse brings a unique perspective to his discussion of the subject. The underlying concepts of the design are briefly explained, as are the limitations and even the errors ("I goofed," he admits at several points). I highly recommend this book, even though a more comprehensive instruction set reference is necessary as a complement. If the assembler documentation does not provide such a reference, then read on.

iAPX 86/88, 186/188 User's Manual: Programmer's Reference
Intel Corp. Literature Dept. Order No. 210911 (Intel Corporation, Santa Clara, CA 1984) 524 pages, paper, $16.95



Intel's *iAPX 86/88, 186/188 User's Manual: Programmer's Reference* is the authoritative reference for the 8086 family. As the title indicates, this volume of the 8086 library is intended for programmers as opposed to hardware designers. Summary information on the hardware characteristics of the chip is included, but only to provide some explanation of the software implications of the design.

Unlike most documentation, this book is highly readable, although it could prove difficult for the assembly language neophyte. The first two chapters introduce the microcomputer in general and the 8086 family in particular, and thus provide a good starting perspective for users of both mainframe and minicomputer systems.

Chapter 3 is the longest and most useful one in the book; it provides an exhaustive definition of the register structure and addressing scheme and includes summary information on writing recursive and reentrant code. It also contains a complete instruction set reference, similar to the one found in the *IBM Assembler Language Reference Manual*. The execution logic of each in-

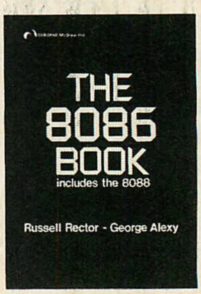
struction is explained in pseudocode. As befits the programming orientation, the instructions are presented in terms of ASM-86 assembly language, not as machine instructions (compare this to the methods of presentation employed by Rector and Alexy that are described below). Execution timings, in terms of the number of clock cycles, are given for each instruction, allowing the programmer to choose the most efficient sequence for performing a given function. The chapter ends with a comprehensive set of programming examples in ASM-86 code (which is directly compatible with MASM).

Chapters 4 and 5 give the hardware design overview for the 86/88 and the 186/188, respectively, and provide full explanations of the interrupt structure. Chapter 6 follows with a description of the 8087 numeric data processor. While this is not as easy to follow as the chapter on the 8087 in IBM's *User's Guide* for MASM, it does provide a definitive and complete reference.

Chapters 7 and 8, which cover the 8089 I/O processor and the 80130 firmware operating system, are not relevant to the PC. The former is interesting, however, for the picture it gives of what the PC could have been had IBM included the 8089 processor in the design.

The Intel manual is an indispensible part of the library of any assembly language programmer, no matter what his level of experience. It is not meant to be read cover to cover, especially by a new user, but to be dipped into as necessary. Each dip will uncover new treasure troves of information.

The 8086 Book
Russell Rector and George Alexy
(Osborne/McGraw Hill, Berkeley, CA 1980) 622 pages, paper, $18.95



The 8086 Book often is cited in assembler manuals as a programmer's reference for information on the characteristics of this microprocessor. Although it is the longest of the three books reviewed here, it provides the least amount of useful information. It attempts to distill the contents of both the programmer's and the hardware designer's volumes of the Intel reference set, but is less than successful and, thus, less than useful as a reference manual for either type of reader.

The presentation has a strangely schizophrenic quality: on one hand, it discusses advanced concepts such as bus timing and interrupt handling; on the other, it describes system software at a very elementary level. Readers who can understand the former hardly need to be told that an editor provides a means of entering and modifying source programs. The book includes no information on how to implement an editor, only before and after examples of typical commands, such as move and delete. Programmers already know this; hardware designers don't care.

A similar dichotomy is evident in the discussions of assembly language programming. The program examples are written in ASM-86, but other sections do not acknowledge any actual assembler implementation. Several methods of distinguishing word and byte operands are suggested, but none is the one used in ASM-86 and MASM.

Another problem involves the description of the architecture of the 8086;

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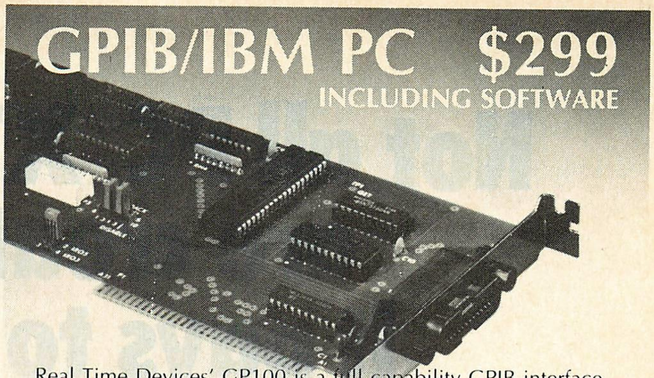

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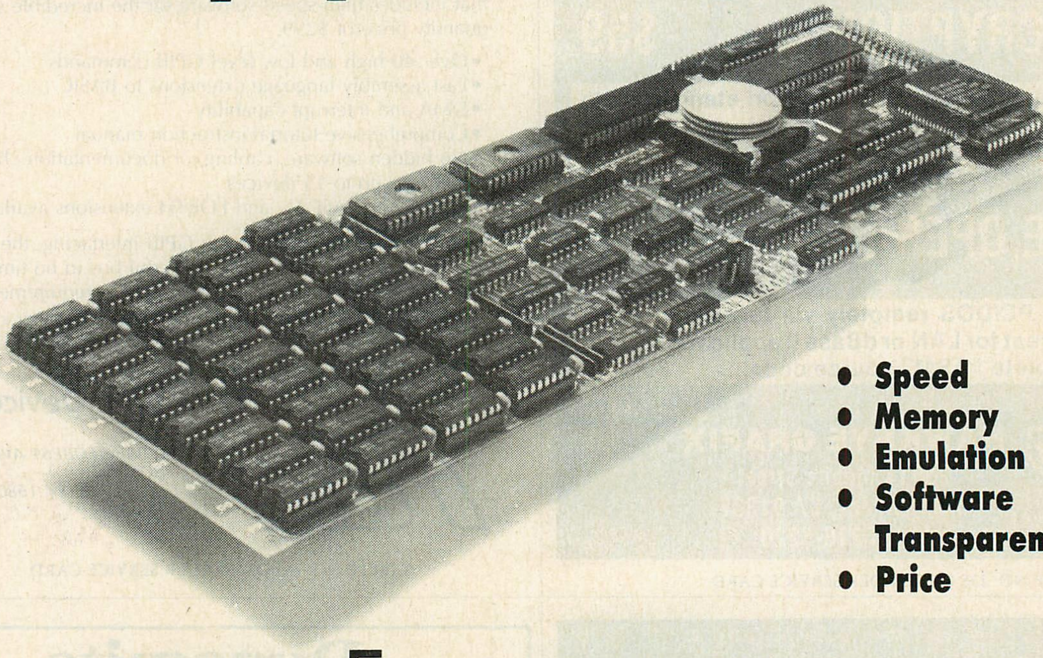

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it is presented in terms of the architecture of the 8080. This would be acceptable if both architectures were fully defined, but the book assumes the reader is familiar with the 8080. For example, the 8086 stack is described as being implemented in the same manner as the stack in the 8080. For PC users without prior knowledge of the 8088, this explanation is obviously insufficient.

The instruction set reference is complete but better suited for the needs of machine language than assembly language programming. For example, seven different move instructions are listed because there are seven ways to encode that instruction into bit patterns. The programmer may well wonder how to choose between the seven methods, but this is not his choice to make. The assembler makes the decision as to which instruction should be used on the basis of the operands. In contrast, the Morse and Intel books (and the IBM assembler reference) describe move as a single instruction, and explain that the assembler takes care of the details. The information on instruction timing provided in *The 8086 Book* is incomplete: no explanations are given of the clock cycles required to generate a memory address, or of the differences between 8086 and 8088 timings.

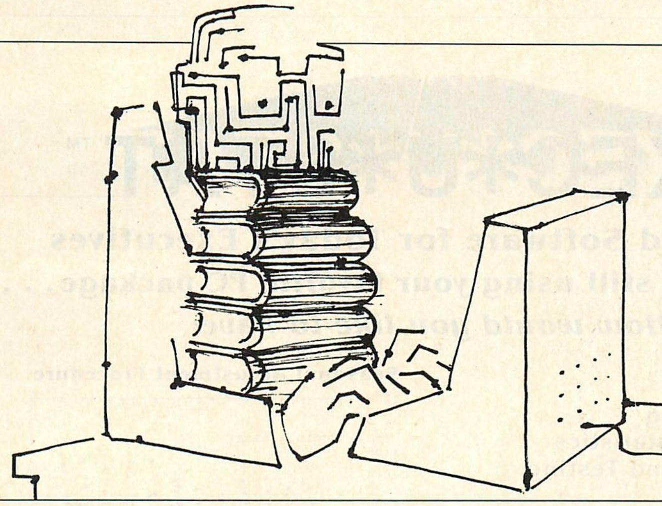
The execution logic of each instruction is illustrated with a diagram of the registers and the flow of data among them. Contrary to the adage that a picture is worth a thousand words, this presentation is not as clear as Intel's use of pseudocode. These diagrams present the operations for updating the instruction pointer as well as those for generating memory addresses. The former are the same for all instructions except jumps and calls; the latter are characteristic of the addressing mode and not of a particular instruction. Each diagram that illustrates the generation of a memory address uses an example with an arbitrarily chosen addressing mode, thus obscuring any symmetry in the instruction set. It is not clear that for a given addressing mode the add, subtract, move, and compare instructions operate in an analogous fashion.

The 8086 Book cannot be recommended for the MASM programmer. Those looking for a reference to help update their knowledge of assembly language would do better to read Morse's *8086/8088 Primer* or Intel's *86/88, 186/188 User's Manual*; these two books can be recommended highly.

—TED MIRECKI

The Ideal Guidebook

The computer professional must be as in touch with the legal aspects of his craft as he is with its technical precision; initial guidance can be found in these books.



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The search continues for a legal guidebook for the computer professional; the primary criteria are scope and balance. The perfect guidebook should address the major areas of law a computer professional is likely to encounter in day-to-day situations. It should cover contract, negligence, and warranty theories, as well as provide guidance. Something can be learned from the story of the client searching for a one-armed lawyer because he is tired of hearing "on the one hand . . . but on the other hand."

On the other hand, this ideal book should accurately present the current state of the law and alert the user to any major uncertainties. For example, much that has been written about the Third Circuit Court Apple v. Franklin decision overstates what the case means. Many writers assert that all computer programs are copyrightable. The Apple v. Franklin case supports that position as does another Apple case in the Ninth Circuit. Both cases, however, involved preliminary proceedings as opposed to trials with fully developed records. The Supreme Court has not addressed the issue, and the Copyright Office still accepts object code under its *rule of doubt*. It may be good practical advice to proceed on the assumption that both source and object code are copyrightable if the consequences of a contrary decision are insignificant. If, however, the consequences are important, the possibility of an adverse result should be considered.

The following books fit the guidebook bill to varying degrees.

***How to Copyright Software.** M. J. Salone and Stephen Elias (Nolo Press, Berkeley, CA, 1984) 218 pages; softcover, $21.95.*

This book is insufficient in scope, but it deals with a most critical and complicated aspect of computer law. In a work of this length on so narrow a topic, the reader might expect great detail and precision. This is not the case. The author makes a general statement in one place that is amplified in another, but does not explain this to the reader.

For example, Salone and Elias assert that a copyright prevents others from exploiting a work for commercial purposes. This is too broad a statement. A major battleground in copyright law is the dividing line between fair use and infringement. Other issues discussed include the right to use reverse-engineering and the copyrightability of functional elements. The authors state the scope of copyright protection a page later, but add, "these rights give the owner . . . exclusive authority to make money from the underlying product protected by copyright." This interpretation is too simple. Contrary examples include the sale of templates for spreadsheet or database management programs, as well as fair use of the copyrighted product in general.

An unanswered issue in copyright law is the extent to which a purchaser may use his single copy of a program. This book tells the reader that "a purchaser has the legal right to do anything they want to the copy of the work they purchase, as long as they do it for their own use." Yet in another place, an example states that a corporate purchaser may not distribute its copy of a program to its 900 branch offices without the author's permission. This is inconsistent—the corporate purchaser is one entity, albeit consisting of many branches. This might well be an issue, depending on the method of distribution. Is it clear, for example, that the program could not be placed on an intracorporate network accessible to all 900 branches? The issue can be dealt with directly by means of a specific agreement between the author and the corporation, yet a reader of the example might not pursue an agreement in the belief that no problem could arise.

The book considers an author who sends a copyrighted program to a marketer and states that the marketer either must buy copies or contract with the author to produce copies. The marketer does, however, have a third option: independently to produce a program using the author's concepts. This is a key problem in marketing through a publisher—authors try to obtain secrecy and noncompetition agreements before disclosing their ideas; publishers try to avoid them.

In spite of these instances, a person who takes the time to read this book cover to cover and think through what first appear to be inconsistencies

should come away with a good idea of the established bounds of copyright law and of the issues that remain open. This would seem to suggest *How to Copyright Software* as a good textbook for a copyright law class, but not a good guidebook for nonlawyer use.

Chapter 10 is the striking exception. This chapter, on deposit requirements, is an excellent guide through the practicalities of how the copyright office deals administratively with the differences between computer programs and ordinary readable text. The discussion is practical and clear, perhaps because it deals with an area of copyright law that is not issue-ridden. Compared to the cost of a lawyer's answers, this chapter alone might be worth the price of the book.

How to Be a Successful Computer Consultant. *Alan R. Simon (McGraw-Hill, New York, NY, 1985) 246 pages; softcover, $16.95.*

Anyone who would buy a book for just one chapter also might consider this one for the section on commercial software. (The remainder of the book is interesting, but beyond the scope of this search.) It approaches the sale of software from the software author's viewpoint, but doing so also provides a useful checklist of what a publisher or end user should consider.

Because Simon's imperatives are in the context of a brief background chapter in a work of much larger scope, he can be forgiven such statements as "*Everyone* who has access to the program prior to publication should sign a nondisclosure agreement" (his emphasis). Ideally this is so, but as noted above, publishers resist doing so for fear they may have a similar program under development, and proving they did not steal it would be expensive. Negotiating nondisclosure agreements and resolving the conflicts that arise in the process is worth an entire book.

The brief summary of legal principles is excellent. Although shorter than the previous book's, Simon's discussion is more precise: he has accurately characterized the uncertainty surrounding copyrightability of object code and the issue of whether copyright and trade secret can coexist.

His conclusions on some points are arguable, but in 10 pages the author covers trade secrets, copyrights, patents, trademarks, contracts, and warranties and alerts the reader to the main problems associated with each. The chapter hardly presents a complete picture, but for a half-hour introduction to computer law, this is a good value.

The Computer User's Legal Guide. *R. Lee Hagelshaw (Chilton, Radner, PA, 1985) 250 pages; softcover, $17.95.*

The scope purportedly covered by Hagelshaw's work puts it within this review's definition of the perfect guidebook. It covers contracts, warranties, copyright, trade secrets, patents, corporations and partnerships, and taxes. Its approach is a mixture of situation- and topic-oriented organization that can lead to confusion. The book includes a section on copyright law, but one of the key issues (whether the user may break the lock on a copy-protected program to make a backup copy) is discussed in a brief paragraph 60 pages earlier. This issue concerns software authors and publishers as well as buyers.

Some advice offered in this book is questionable. The discussion of copyright offers two forms of copyright notice: the © symbol followed by the date, the author, and "All Rights Reserved," or the same form with the word *copy-*

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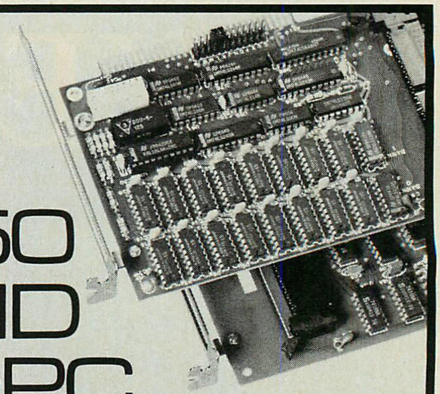

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right substituted for ©. Hagelshaw notes that the phrase "All Rights Reserved" is not required for U.S. copyright, but is in some other countries; however, he does not warn that the use of the word *copyright* may not be effective in some countries. Because few computers have a © key, it seems that readers would opt for the word copyright and potentially lose rights outside of the United States.

His approach to the difficult issue of source code escrows should have been more cautious. The book suggests language that requires release of the escrow upon "failure of the developer to meet maintenance or updating obligations . . ." An escrow agent should be uncomfortable with such a provision because users and authors commonly have different views on the adequacy of maintenance and updating. An escrow agent does not want to act as referee.

Overall, the treatment is practical, legally sound, and innovative. For example, the section on holding the salesperson to his promises begins by acknowledging that manufacturers and publishers are in a better bargaining position than the average microcomputer user. Most guidebooks point this out, but *The Computer User's Legal Guide* goes one step further and advises the reader how to handle such situations.

The example is a buyer who has been told by a salesman that a particular computer will meet his needs. After noting the likelihood that the deal will include a standard printed disclaimer of warranties, the author suggests an alternative theory of misrepresentation, since that theory does not rely on breach of warranty. He also recommends rejecting the manufacturer's warranty (on the theory that this rejection also will cancel the limitations contained in the warranty) and attaching any advertising brochures (with the salesman's signature, if possible) to the sales receipt. This represents creative thinking and is worth considering.

Even with its flaws this work is a candidate for the perfect guidebook.

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For users with specific interests, general guidance pamphlets are published by the U.S. Patent, Trademark, and Copyright Offices: "General Information Concerning Patents" by the Patents Office and "General Information Trademarks" by the Trademarks Office (U.S. Department of Commerce, Washington DC 20231), and Circular R1 "The Nuts and Bolts of Copyright" by the Copyright Office (Library of Congress, Washington DC 20559). While these pieces concentrate on the agencies' filing procedures, they do contain information on the scope of protection offered by these filings. Since trademarks also may be protected by state laws, it is worth checking with an individual state's filing office for available publications.

In considering any legal guidebook, the computer professional should bear in mind, as R. Lee Hagelshaw says, that "This publication . . . is sold with the understanding that the author and publisher are not engaged in a profesional relationship with the reader and are not rendering legal or other professional services. If legal advice or other expert assistance is required, the services of a competent professsional should be sought," and, as Salone and Elias say, "Unfortunately, there are . . . a number of so-called 'computer lawyers' who awarded themselves the title for no other reason than it looks like a hot field in which big bucks can be made in a hurry."

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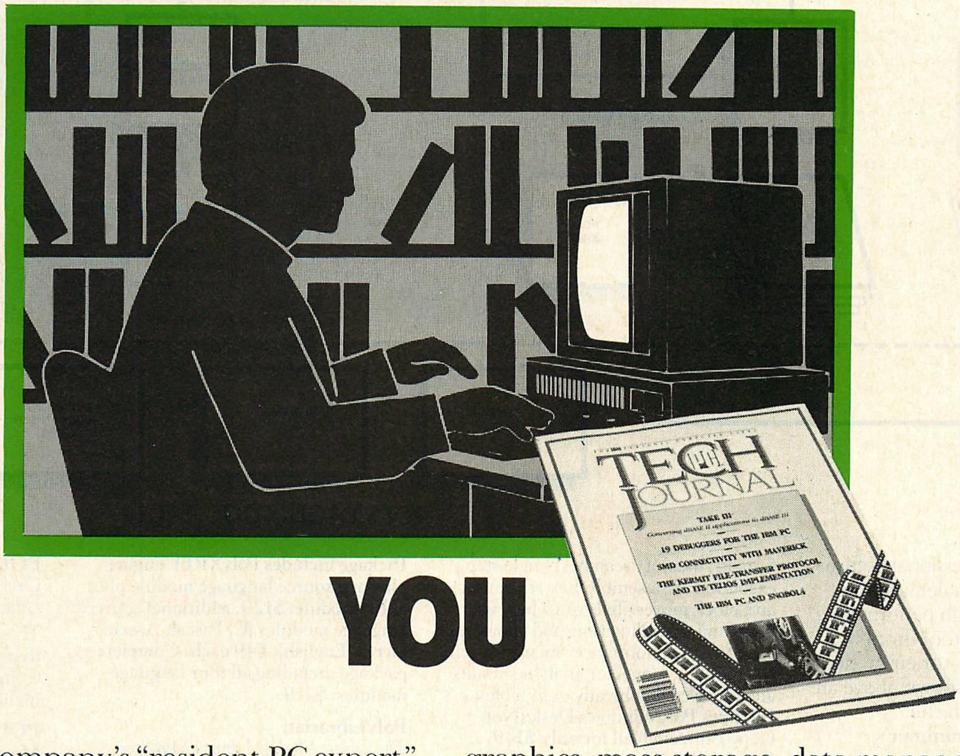

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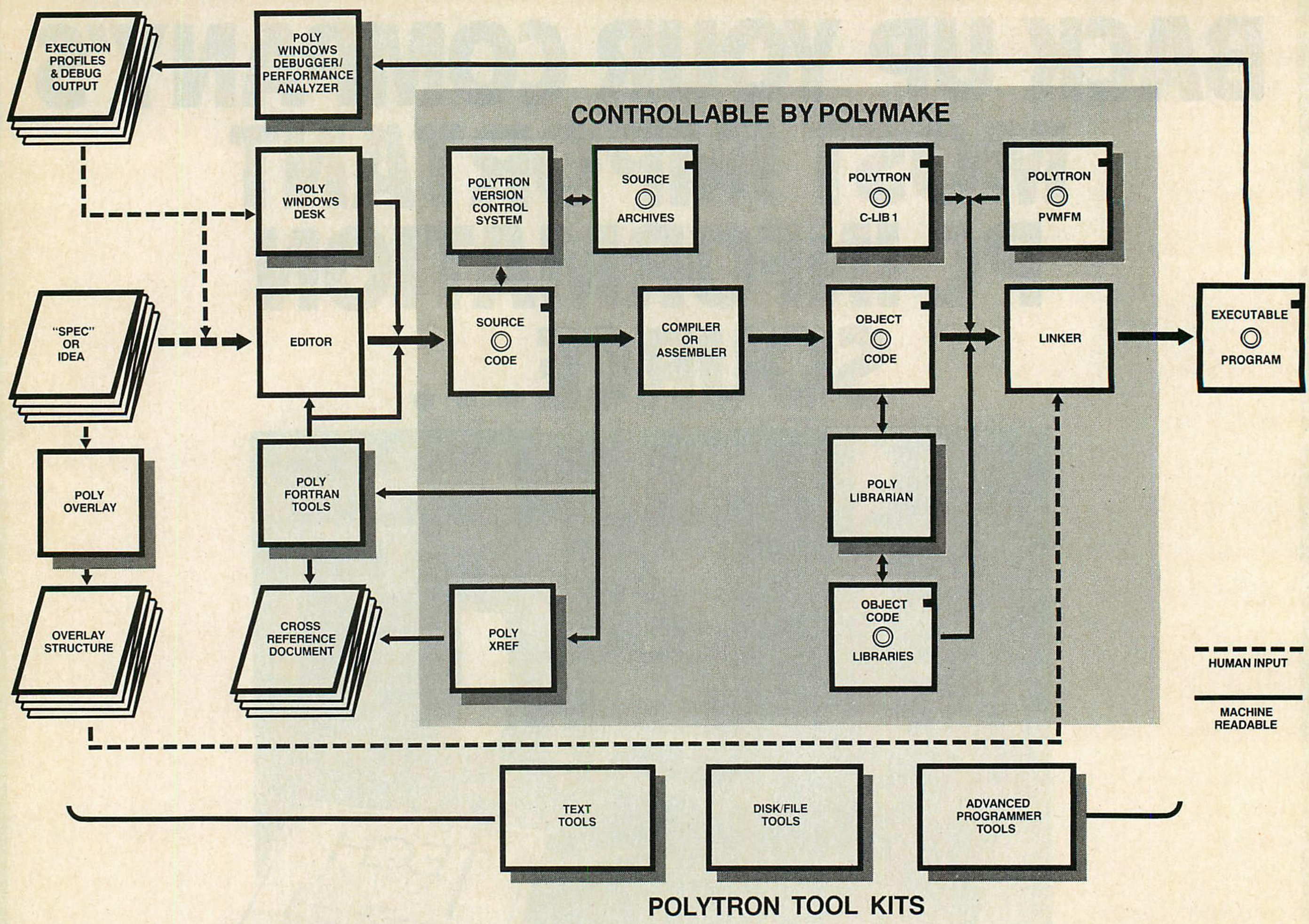

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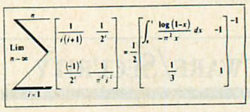

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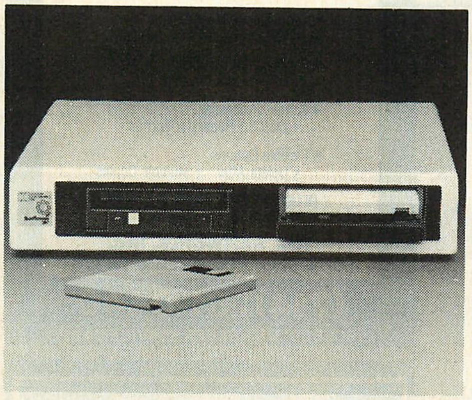

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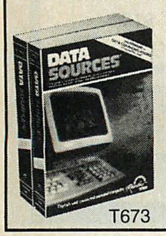

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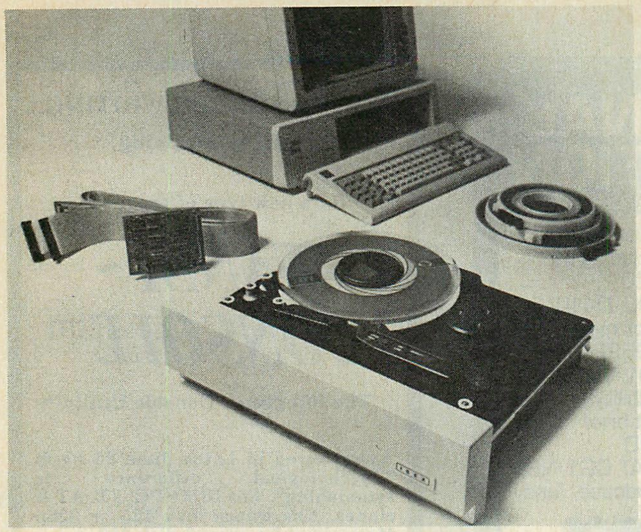

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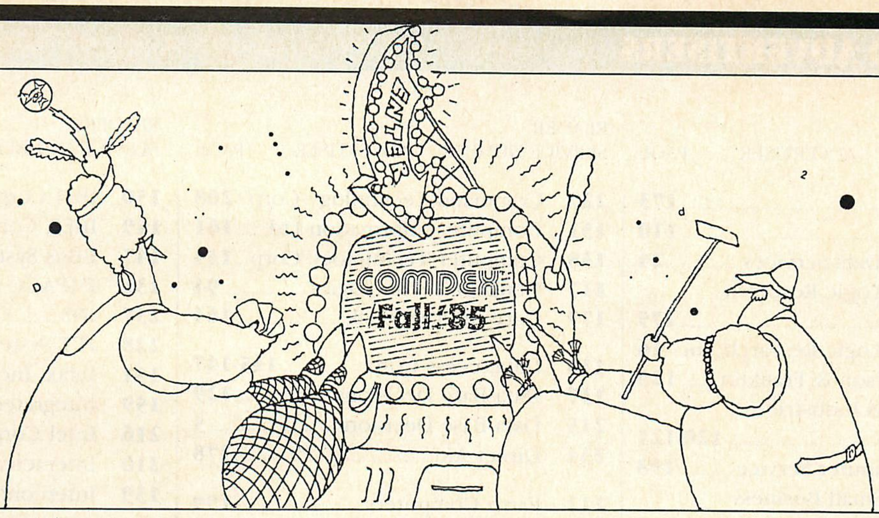

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